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ABSTRACT

The recent microelectronics developments are having, and will continue to have, a sharp impact on various industries in Great Britain, and thus on the capacity of the Further Education System to produce qualified graduates. To maintain a high quality of education, instructors must learn of these new developments and teach them to their vocational students, who generally will require more skills to cope with changing jobs and technologies. Technology-based students need to widen their range of skills to include computer-based techniques in engineering, business and management, stores, hotels, and restaurants, public service utilities, trade unions and professional associations, and education and accrediting agencies. Universally, employers are calling for improved basic skills, such as use of good English and good mathematical skills; the ability to communicate and translate data to and from consumers; the establishment of productive work values; the ability to work effectively with others; and, a knowledge of the basic structure of industry and commerce. The need exists to bring closer together technical and basic skills, which the Further Education Programs are currently planning to accomplish. (KC)

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Further Education Curriculum Review and Development Unit

AN OCCASIONAL PAPER

MICROELECTRONICS IN F.E.

Some personal perceptions

October 1981

CE 033 163

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(1) reviewing the range of existing curricula and identifying overlap, duplication and deficiencies

(2) determining priorities for action to improve the total provision and suggesting ways in which improvement can be improvement can be effected

(3) carrying out specific studies, helping with curricular experiments, and contribution to the evaluation of objectives, and

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October 1981

Jack Mansell
Director

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FURTHER EDUCATION CURRICULUM REVIEW AND DEVELOPMENT UNIT

OCCASIONAL PAPER

MICROELECTRONICS IN FE:
Some personal perceptiors

K J DEAN

South East London College, ILEA

"Small chips fell tall trees"

(pseudoChinese proverb)

FURTHER EDUCATION CURRICULUM REVIEW AND DEVELOPMENT UNIT

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FEU FOREWORD

1. The report that follows by Dr Ken Dean is not a typical FEU publication, in that it is a collection of personal perspectives in a fast moving field of activity. It is ephemeral but timely, anecdotal but informative, contradictory but valuable. As such the FEU is publishing it as an Occasional Paper and distributing it on a different basis than normally applies to its Projects Reports, but one which is appropriate to its conclusions.

2. This document should help, in part at least, the education system, to appreciate the nature of a fast-moving technology which is distorting and elongating the convential spectrum of skills that are required by society. Some areas of industry and commerce have only a primitive awareness of how and where the impact of micro-electronics will be felt; others are already exploiting the technology to an extent yet to be evaluated by the industry itself.

3. This unevenness of progress results in speculations ranging from the obvious to the futuristic, not without contradictions. Ken Dean's report catches the uncertainty that pervades many of the organisations that he visited and in two years he may well need to write another report, up-dating many of his perceptions. In the meantime, the main curricular message to be received by the education sector appears to be one of increasing demand on the system, not so much in terms of more students but more in terms of quality.

4. On the basis of this report, there are few skills that we can discard at the moment from educational programmes. Students generally will require more not less skills, to cope with changing jobs and technology. If there is much uncertainty in the document as to whether or not we need more technicians there is less about the nature and range of skills required. Technology-based students need to widen their range of skills to embrace computer-based techniques and this seems to be an area in which the technical validating bodies could assume a major responsibility. We must now be at the point where all technology-based curricula, to remain valid, must have designed into them an appropriate element of computering skill.

5. An even more fundamental point emerging from this report, is the universal call from employers for more basic skills, good English, good numeracy; the ability to communicate, translate and mediate data to and from

consumers in an acceptable way; values and motivation; flexibility, the ability to work with others; a knowledge of the basic structure of industry and commerce.... As one of the concluding paragraphs in the report indicates "three kinds of skill are needed: life skills, work skills and learning skills". It has all been said many times before. This investigation, however incomplete and anecdotal, provides an unsolicited validation to the curricular recommendations made by the many bodies* calling for a common-core of basic skills to be included in all programmes of vocational preparation.

6. The technological implications of microelectronics are tentatively explored in this document. Less tentative is the evidence indicating that the accelerating availability of data is producing a need to bring closer together technical and basic skills. The FEU is working in this area, alongside other agencies, but in the meantime a radical re-appraisal of many of our technological curricula and the context in which we teach them appears overdue.

Jack Mansell
August 1981

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* See for example "A Basis for Choice" FEU 1979
"Foundations for Working Life" SCRAC 1980
"Vocational Preparation" FEU 1981

PREFACE

One of the more unpleasant experiences of life is to be caught unawares, and one of the least common virtues is to admit to it. It is to avoid the former and the embarrassment of the latter that we undertake exercises under the guise of 'forward planning' or 'advance stochastic assessment'. This report describes one such attempt to correlate the intelligent guesses of people who ought to know, about the impact of microelectronic technology.

In the last three years there have been many other exercises which also started from the realisation that this new technology is likely to affect society in a number of important and far reaching ways. For example, some of the texts in the bibliography have been written to draw attention to the ways in which certain skills may be no longer relevant in industry. There are instances of the demise of labour-intensive industries, such as the manufacture of mechanical calculators and watches, and many writers have forecast widespread unemployment. Issues such as this have been widely debated not only in the sources quoted but in the press and especially on radio and television.

It is not intended that this report should add to that debate, except perhaps incidentally. Its main concern is the possible effect upon the curricula of courses in further education colleges and the skills needed; in short, what we teach and how we teach it. Nevertheless during the investigation on which the report is based, a number of interesting byroads come into view: what will our colleges be like? Will we need more technicians? Or fewer? Will shorthand survive? Are we witnessing the birth of a cashless society? And many more.

Written in an admittedly anecdotal style, the report aims to describe the opinions and experiences of industrialists, bankers, trades union officials, training officers, university and college staff and a host of others; and to identify some common themes which directly bear on the provision of a relevant further education service. It is a snapshot of perceptions.

This project started as a proposal to the ILEA by the author for a four-month period of sabbatical leave and thanks are due to that Authority for agreeing to this. The FEU supported the work through financing the travel within the UK and to a limited extent in the USA. The Higher Education Research and Special

Expenses Fund (administered by ILEA) also helped. The Further Education Staff College at Blagdon provided accommodation and assistance in writing up the work. Although the help of these organisations is acknowledged in Appendix 1, the author here wishes to express his appreciation of the continuing interest and unstinting help that he has received from the officers of these organisations.

It should be clearly understood that whilst the text of this Report might be thought to imply the contrary, contributing individuals were not asked to limit their remarks to agreed expressions of company policy, but to give their opinions freely, based as they often were on many years experience. Whilst it is hoped that corporate veiwpoints have not been misrepresented, if in any instance this is not so, I would like to express my apologies for any embarrassment caused.

K J Dean
August 1981

CONTENTS

		Paragraph(s)
FEU FOREWORD		
PREFACE		
PART ONE	- THE BACKGROUND	
	Introduction	1
	The background of technology	2 - 6
	The background of response	7 - 20
	The economic background	21 - 22
PART TWO	- THE AIM AND CONDUCT OF THE PROJECT	
	A period of change	23 - 27
	Educational problems of change	28 - 32
	The impact on society	33 - 36
	The impact on student education and training	37 - 46
	The conduct of the investigation	47 - 48
PART THREE	- PERSPECTIVES FROM ENGINEERING	
	Semiconductor manufacturers	49 - 58
	Electronic equipment manufacturers	59 - 74
PART FOUR	- PERSPECTIVES FROM THE BUSINESS AND MANAGEMENT SECTOR	75
	The equipment	76 - 80
	Banking	81 - 91
	Accountancy and law	92
	Insurance	93 - 95
PART FIVE	- PERSPECTIVES FROM STORES, HOTELS AND RESTAURANTS	
	Multiples and department stores	96 - 104
	Hotels and restaurants	105 - 113
PART SIX	- PERSPECTIVES FROM THE PUBLIC SERVICE UTILITIES	114
	Public transport	115 - 124
	Electricity supply	125
	Gas supply	126 - 129
	The television service	130 - 131
	Television rental	132
	British Telecom (including Viewdata and Teletext)	133 - 140
PART SEVEN	- PERSPECTIVES FROM TRADE UNIONS AND PROFESSIONAL ASSOCIATIONS	
	Professional and Commercial trade-unions in the UK	141 - 149
	The teaching unions	150 - 152
	Trade-unions in the USA	153
	Trade-unions in Europe	154 - 155

		Paragraph(s)
PART EIGHT -	PERSPECTIVES FROM THE EDUCATION SECTOR AND THE EXAMINING BODIES	
	General introduction	156 - 163
	Secondary education	164 - 167
	Higher education	168 - 173
	Further education	174 - 178
	Further education in the USA	179 - 183
	The Council for Educational Technology	184
	The Technician Education Council	185
	The Business Education Council	186
	The Royal Society of Arts	187
PART NINE -	CONCLUSIONS	
	Some general conclusions	188 - 189
	Areas of interest	190
	The Specialists	191
	Users of microelectronics at work	192
	Medium technology	193
	The general public	194
	Teacher training	195
APPENDICES		
1.	Acknowledgements	
2.	The Nature of the Investigation	
3.	References and a Bibliography	

PART ONE - THE BACKGROUND

1. The aim of this project and its report is to investigate the changes which advances in microelectronics (especially the applications of microprocessors) are likely to bring about in curricula in further education. Any recommendations which the report makes are in the light of initiatives already taking place in education and training with particular reference to FE.

2. THE BACKGROUND OF TECHNOLOGY

The development of microelectronics can be traced back to the work of J Bardeen and W H Brattain in 1948 who developed the first point-contact transistor. Work in UK started in 1953 and it was soon recognised that junction transistors were superior and by 1960 that silicon was the best material with which to make them. G W A Dummer of the Royal Radar Establishment, now at Malvern, speaking at a transistor conference in Washington pointed out that semiconductors could be used to make resistors, capacitors, diodes and transistors and thus to bring together the majority of the elements of electronic circuits. The possibility of putting together a number of these elements on a single piece of semiconductor was now realised. /1/

3. In 1958 Texas Instruments Inc first produced integrated circuits on a single slice of semiconductor. Quickly the other manufacturers followed. From then on, as knowledge of the technology improved, it was a race to manufacture and sell the largest and most complex circuits. These were produced by step-and-repeat photolithographic techniques on thin circular slices of silicon. The earliest wafers were one-inch diameter with say, ten circuits. This has steadily grown until five-inch wafers with 250 circuits are in common use today. The problem in the late 60's was to exploit the circuit which would be complex enough to warrant the use of this technology and general enough to make it economically attractive.

4. Amongst the earlier solutions to this dilemma were chips comprising solid state memory circuits. This suggested that if an arithmetic unit could also be fabricated, preferably with some of its control circuits, it would be, in

effect, a computer on a chip, or at least on a small number of chips. This would undoubtedly be a profitable undertaking. The first microprocessor was introduced by Intel Corporation in 1975. Its 4-bit arithmetic was appropriate for the design of simple TV games and crude robotics. 8-, 16- and (in 1981) 32-bit microprocessors are now available as well as substantial random access and read-only memory circuits on silicon. Alongside the development of the hardware of microcomputers was the need for programs (software) to control them.

5. However, the development of microelectronics is only one strand in modern technology. There had also been considerable developments in telecommunications. Today the introduction of digital telephony circuits, typified by Systems X has already been commenced by British Telecom (formerly Post Office Telecommunications). We have also seen the introduction of teletext (such as Ceefax and Oracle) as an information service using television. The linkage of television and telephone facilities, Viewdata, has so far made a modest start in UK (Prestel), and is slower still in USA.

6. This report is, concerned, therefore with these three forms of technology - computing, telephony and television - and the effect of the rapid growth of their application throughout much of industry in UK on the education of young people and their preparation for a world where such applications are commonplace and pervasive.

7. THE BACKGROUND OF RESPONSE

The impact of microelectronics on society at home and abroad has already been the subject of many reports and books, some of which purport to foretell its impact on industry, commerce and the essential fabric of society over the next few years. At one extreme it has been suggested that widespread and mounting unemployment is just around the corner, as long-established trades, crafts and other skills are overtaken by the applications of microelectronics. The alternative view claims that the new technology will bring with it new jobs to replace those that are no longer needed in modern society. To all this is added the open question, "What is the relevance of the work ethic to us today?" Some people see a future where full-time employment is not the norm, even those who do work will be able to work more readily at home.

8. An Economic Progress Report published by the Treasury in February 1979 drew attention to this issue when it stated that there would be job gains as well as job losses, and added that this was based on previous experience with those sectors, and indeed countries that had had the best record of innovation-led productivity growth. Surely there was no reason to doubt that this could be the case with microelectronics? Unfortunately not everyone saw it in those terms. Unemployment had been rising to new record levels in excess of 3 million, arguably due principally to causes other than the introduction of micro-electronics. Could it be that was still to come with more problems of social unrest to follow?

9. All this has implications for education and the Economic Progress Report drew attention to the fact that educational institutions are already involved in retraining people employed in industry. In the longer term it stated, "...the education system will have an increasing role to play." This report looks into the nature of that role and assesses how long 'the longer term' may be. 1979 saw the introduction of two notable books. Clive Jenkins was the co-author of one of them /2/ and in it he predicted in excess of 4 million unemployed. It had the effect of bringing to the British public's attention the implications of microelectronics in terms which they could understand, even though they might consider some of the conclusions extreme. Ian Barron, now Director of INMOS, was co-author of the second /3/. It published the results of a study sponsored by the Department of Industry in 1977. In it he foresaw in the short term a serious training problem related to the exploitation of microcomputers. Revision of relevant degree courses and training for engineers and programmers in the industry had to be regarded as an urgent matter. However, beyond this the authors saw that multi-discipline courses were needed, embracing computing, electronics and telecommunications, to replace coursesbased on individual disciplines. They warned that in due course information technology is likely to restructure the jobs of many people, either by changing the way the job is done or even by eliminating it altogether. Thus, it follows that the role of education will be subject to serious change.

10. By 1978 within the Department of Industry the government had set up the Microprocessor Application Project (MAP). This was intended to help companies

which wished to explore the feasibility of microprocessor technology in the products which they either manufactured or were considering manufacturing. This was arranged in three parts:-

i. Industrial awareness and training,
ii. consultancy support and initial feasibility studies;
and iii. active support for a firm application.

11. In October of the same year the Department of Education and Science (DES) wrote to the Standing Conference of Regional Advisory Councils regarding the educational implications of microelectronic technology. After drawing attention to existing initiatives, the letter went on to say that it was necessary to promote a better understanding of the technical and economic issues involved. (Notwithstanding the fact that these were being brought home to the public quite forcibly through books and TV programmes). The letter pointed to a need to consider the training and retraining of the existing work force and the long term implications of the new technology for the education service itself. In addition to this there were the wider social economic implications for the future structure of the employment market. The letter sought to establish constructive responses from the educational community and implied that further action would follow shortly. In March 1980 the DES announced the Microelectronics Development Programme for schools and colleges (MEP).

12. There had also been a DES consultative paper seeking suggestions for funding curriculum development projects and developing initial and in-service training courses for teachers, and offering the direct funding of in-service courses in microelectronics. Thus, MEP was to handle a nine million pound programme over four years for schools and colleges. In November 1980 the DES announced a first list of 29 projects which had been given the go-ahead, amounting in all to £900,000. Of this only one sum of £2,000 to the CET for the production of leaflets detailing sources of information about microelectronics was stated to be for schools and colleges. Apart from this there was no specific reference to FE though doubtless some of the money would have been spent in ways appropriate to that sector.

13. Separate directors were appointed for the MEP in England and in Scotland. The English MEP, which includes Wales and Northern Ireland, is administered

financially by the Council for Educational Technology (CET) but is responsible to DES. The scheme was not formally launched until April 1981 when the Prime Minister stated that it was her intention to see a microcomputer in every school in the UK, hopefully by the end of 1982. At the same time the Department of Industry had decided to recommend to schools the purchase of two computer packages; one, supplied by Research Machines Ltd of Oxford, the 380Z, was already popular with many Local Education Authorities. The other was a more modest system manufactured by Acorn Computers of Cambridge for less than £300. Priority would be given to those schools which had no computer. The funding was intended to match pound for pound government money with that obtained from either local industry or the LEAs.

14. MEP produced a strategy document in April 1981. Here again the programme was concerned mainly with schools, but also with those in courses for 16-19 years old in further education. It recognised that microelectronics and its applications would also be an important feature of vocational education and training, but went on to explain that support for these fields would be resources beyond those available. Nevertheless the Strategy Paper assumed that FE colleges and polytechnics would contribute to in-service training for teachers in schools and to the pilot courses supported under the programme. The three activities which the programme outlined were:-

i. Curriculum development,
ii. teacher training;
and iii. resource organisation and support.

Interestedly, that the strategy document stated that the programme was intended to support the production of teaching and learning materials, including software.

15. The relationship between vocational training and microelectronics was first raised in the European Council in November 1979, and subsequently discussed by the Standing Committee on Employment in February 1980 and the Consultative Committee for Vocational Training in March 1980. A report was commissioned from British consultants /4/ by the Directorate for Employment and Vocational Training of the Commission of the European Community. When the

report appeared in 1980 it too drew attention to the way in which many occupational profiles used for vocational education and training would lose their relevence because either the occupations had disappeared or had changed out of all recognition. The Report, however, seemed to make its recommendations in terms of secondary education. For example it states that, "The new technology will reduce the distinctions between work and life skills. This will have important consequences on the aims of school." The report naturally places more emphasis on training than on education, though it does suggest that some help can be given to cope with the more obvious aspects of the new technology, and this it says can be "...given to school children immediately." It goes on to suggest that the more we move into higher technology the more we shall succeed in having decentralised industry, and the more we shall discover that highly specific job training will be needed at each of the different levels of responsibility and action. However, it insists that it will be impossible to obtain this training anywhere else but on the job.

16. In Britain by 1979 the Training Boards were beginning to become involved in the problems associated with microelectronics. Two of the Boards are mentioned here by way of example. The Engineering Industry Training Board (EITB) produced its paper IP52, 'Training for Microelectronics Applications and Computing'. This was boldly subtitled, 'A Programme of Action' and indicated that the Board was offering companies a grant of £50 per week for 20 weeks of off-the-job training for employees attending the new first level programming courses of the Business Education Council/Technician Education Council (BEC/TEC) Certificate in Computer Studies. The course is aimed at 16-year old school leavers, but is also suitable for some older employees. It is offered at some Colleges for Further Education.

17. The Chemical and Allied Products Industry Training Board had received a sum of £80,000 from the Manpower Services Commission and was proposing to make grants available for various sums up to £80 per week per employee for courses on initial programming, real time programming and systems analysis. Later in November 1980 it was offering seminars including introduction to microelectronic technology and word processing.

18. The DES provides assessors for the training boards and the assessor for the EITB has a general responsibility for new technology and especially for the

implications and implementation of microelectronics. The DES has been interested in the steps which our colleges have taken themselves to ensure that teaching staff are aware of what is happening in society and what the implications are for what they teach. DES has always been concerned about the ways in which computing facilities are being used.

19. It may be because of the ways in which certain local education authorities have made economies in the last few years, that efforts have been counterproductive in this area of activity. For example, staff with special skills in microelectronics or computing are greatly in demand and thus very mobile. If teaching posts are frozen or levels of vacancy are too low, they cannot be easily attracted into that authority's service; in-service staff development is then the only way forward.

20. It would seem that the general awareness of the public in this country is high because of the reasons already given, but it may be in some areas of the country, further education staff and managers have not thought through all the implications of the new technology. The development of programmed material (software) is particularly important to control the modes of operation of the hardware. It may have been that computing in general and micro-computers in particular have been held back by lack of expertise in this area, and the consequent shortage of reliable programs and programmers. This shortage seems not to be peculiar to this country alone.

21. ECONOMIC BACKGROUND

The world semiconductor market was valued in 1980 at 14,000 million US dollars. The UK had 4.78% of this market and a 7% growth rate (higher than most of the remainder of the British economy). In 1981 the world market had risen to 15,520 million dollars and the UK share was 4.57% of the market with a 6% growth. This compares poorly with the performance of the market leader, the USA, which had 42.8% of the market in 1980 (with 30% growth) and 42.9% in 1981. The figures for Francefor 1980 and 1981 were slightly less than those for the UK but the growth rates were substantially higher. As early as 1978 the French public was made aware that all was not well by a report on the new technology to the President of France /5/. It drew attention to the risk of unemployment, and pointed out the need to achieve and maintain a satisfactory level of productivity which was crucial to the survival of the nation. It showed that

the French economy has suffered from a continuous deficit in the trade balance, a weakening of the traditional domestic demand and a worsening of unemployment - conditions not unlike those to be found in the UK over the last few years. The early publicity this report gained in France has given the French a valuable opportunity to effect a reassessment of their position and their educational needs.

22. An early pointer in the UK of what was to come was in a paper by Professor Gosling. He wrote, "Nobody knows what the combined impact of all this technolgoy will be". A little later in the same document /6/ he wrote that in his opinion, "There is probably no industry that technology will not affect, revolutionising production processes and the organisation of the firm, even if not of the product". Regretfully he concluded that, "None of us dare begin to say what the consequences of this new technology will be for education... in the years to come".

An important underlying factor, in the UK at least, is the growth over the last twenty years in the proportion of jobs in the service sector. This growth of employment has come from expansion, firstly of education and medicine, and secondly of those service industries, especially distribution, banking, insurance and finance which essentially have to do with material goods and their ownership. Thirdly there are those service occupations such as managers, technologists and other professionals whose activities improve the efficiency of our system of material production. The impact of microelectronics, particularly in office and on these hitherto buoyant areas of employment, information technology is likely to be very significant.

PART TWO - THE AIM AND CONDUCT OF THE PROJECT

23. A PERIOD OF CHANGE

The years since 1945 have been characterised by a substantial change in the technologies referred to in part I. The services provided in the UK by Post Office Telecommunications (now British Telecom) have been in a constant state of development. Manual exchanges have been replaced by automatic ones; STD was adopted throughout the country; calls can now be dialled to most parts of the world; most recently of all the introduction of electronic exchanges based on Systems X has commenced.

24. Developments in electronics have already been discussed in Part I. However, the point which needs to be made here is that the impact of these changes on telecommunications and later, on computing, are of considerable significance for this present project. The reliability of thermionic valve circuits particularly in large systems was poor. Early transistors, made as they were by hit-or-miss methods were better, but it was only with the later planar transistors that worthwhile and reproducible devices became available. Circuit design was based upon choosing the optimum selection of components to produce for example, an amplifier of known characteristics of gain and frequency response. When planar integrated circuits first appeared they were all based on digital functions. The new digital electronics then used logical functions to achieve an overall characteristic based on the logical performance specified by the designer. When the logic gates were say, AND or OR gates and storage (or memory) was by bistable flip-flops (also silicon chips) the ultimate performance might have been a reversible shift register or a counter operating in some specified code.

Later, shift registers and counters and code converters were produced by the semi-conductor manufacturer as typical single chip elements, and no longer needed to be fabricated from individual gates by the systems designer.

25. To summarise: circuit design combining individual circuit elements had been replaced by the design of complete digital circuits. This in turn gave way to larger, more complex systems design, combining logical subsystems, with

whatever logical gates were needed. Now the subsystems could become still more sophisticated - namely, large scale memories and microprocessors on individual semi-conductor chips.

26. The origins of computing, like those of semi-conductor electronics, could be said to owe much to war time research and development. The early computers used electronic valves and as they became more complex their reliance on valves, each containing a heating filament and the consequent need for cooling, emphasised their unreliability. The next generation used transistors, the memory function being obtained from ferrite cores and later from rotating magnetic drums. Integrated circuits using clusters of logical gates then followed. Each change seemed to reduce the electric power demands of the total system and also its physical size. Mini-computers, the size of an office desk, began to win a share of the market. One of the reasons why electronics equipment manufacturers were urged to use digital circuits was that volume markets in digital computers had reduced their price. Hence electronic test equipment began to follow the same general design philosophy as used in computing.

Single chip microprocessors were designed as building blocks for micro-computers. Their complexity was soon able to match that of mini-computers but now they were small enough to fit on to the top of the desk.

27. This section has attempted to highlight the changes which have taken place in the last 35 years and the ways in which the design technologies appropriate to telecommunications, electronics and computing were rapidly converging. Not only were computers linked by telephone circuit but their peripherals (visual display units, printers, etc) were compatible with an overall design philosophy that embraced these three technologies. This compatibility was brought about by the fact that digital techniques were common to them all. Now it has been possible for many years to see this convergence taking place. However in the last few years the rate of convergence has clearly increased so that it is possibly no exaggeration to suggest that present or imminent applications are likely to affect the whole way of life of western society.

28. EDUCATIONAL PROBLEMS OF CHANGE

People writing about the effects of change brought about by developments in microelectronics have often likened it to previous changes in society such as that brought about by the introduction of the steam engine and the early use of electric motors. These innovations it is claimed, have been followed by periods of worsening unemployment. At a later stage new industry, related to the new technology, has come in to increase the employment opportunities to above the earlier level and to raise the standard of life at that time. This, it is said, could well take place with microelectronics too. In each of these cases there have been periods when employment associated with the old technology became unprofitable, consequently declined and even ceased. This we are certainly seeing today. The argument continues that it was only subsequently when the new technology was well understood and integrated into educational curricula that new industries took over and became profitable.

29. Experience post-war with the teaching of electronics has required frequent updating as new technology replaced the old. Thus the FE lecturer who taught valve theory found that transistor theory needed to be included, and subsequently the earlier technology was completely displaced. The introductions of transistors, integrated circuits and now microprocessors have been identified as 'quantum' steps accompanied by an urgent need for retraining. However, there has always been an inertia accompanying with change, so that, for example, the circuit design associated with early transistor circuits looked remarkably like that of valve circuits, but with the supply voltages 'scaled down' to meet the new operating supply levels. This may in part have been due to the continuing presence of industry using the old technology, but also it indicated a training fault, in that the new technology was thought of as an extension of the old and working under similar conditions. This problem can be highlighted by the example of organisations who had purchased test equipment based on the old technology, or those cases where companies manufactured the old technology and were under some obligation to maintain such systems for many years after they were sold. A typical case is that of aerospace where companies making missile systems had some obligation to maintain those systems even though the country to which they had been initially sold had subsequently resold them.

This might mean that systems 15 years out of production still carried servicing commitment from aerospace companies in this country. Such companies needed to employ staff who could carry out such maintenance, requiring the FE service to train such people.

30. One of the problems of technological change is the motivation of teaching staff working in this discipline. With the exception of computing science the involvement of the secondary sector of the education service in the converging technologies has been slight. In the case of computing, even without government support it is clear that a large number of schools have by now bought microcomputers. They have since found that the provision of suitable software for them is not possible within their own resources alone and they have called on industry or FHE for help. Software from MEP and the BBC computing literacy programme is also beginning to help here.

31. In higher education, concerned as it is with the education of graduates, there are outstanding examples of institutions which have been particularly sensitive to these issues, and close liaison has often been the case between university or polytechnic and industry at the forefront of innovation. In this sector and in further education the problem of staff motivation has been paramount. Where this has been good the results have matched or exceeded the expectations.

32. The FE sector has traditionally seen its role as meeting the vocational needs of students. The insistence of the Business Education Council (BEC) and the Technician Education Council (TEC) on looking at curricula in a new way, namely that of setting out learning objectives and of objective testing, has helped to prompt revision of course material at an appropriate time. This has given impetus in a number of colleges just when it was needed. However, the extent of the change brought about by the introduction of microprocessors has been so great that perhaps the challenge has not been adequately met by some so far.

33. THE IMPACT ON SOCIETY

The impact of the convergence of the technologies mentioned in paragraph 27 could well affect all members of society and it is felt that the argument that this could be so immediate that three areas of interest will be examined.

34. The specialists

The first and most obvious area of interest is that of the practitioners of the new technologies. Those who work whether as scientists, engineers or technicians in areas such as telecommunications or electronic engineering will clearly feel the impact of the new technologies first.

Although the impact on them will be less, there are those who are working in computing in one form or another, and find that new physically smaller, but as powerful machines are coming forward to replace older mainframe computers. Such people may be working in either hardware design or maintenance or the manufacture of software or some combination of the two. It has often been the case in the past that people were proficient in either software or hardware but seldom in both. It could well be that the new technology will require specialist practitioners to have more than a mere working knowledge of both software and hardware.

35. The users

People who use electronic equipment but do not have to maintain it, will clearly need to know about the new technology, but probably less than those who are specialists, such as systems designers. The applications of new technology, therefore, introduces whole ranges of new users. It will have its impact on those who used electronic equipment for whatever purpose. Clearly the use of word processors by secretaries comes within this section, as does the use of automatic tellers by bank staff, or robots by those controlling assembly lines.

36. The public

A moment's consideration of technological developments over the last five years indicates what one estimate of the future might contain. There are those, however, who think that the rate of innovation is rapidly accelerating. For example, the service which the public gets from various utilities, such as energy supply is metered electronically (petrol) or will be so in the near future (gas, electricity) dispensing with the need for manual meter reading. Already the public is largely used to receiving invoices which are prepared by

computers although it may not be realised that these are turn-round documents, used to input the same data bases when payment is made. The public is now becoming familiar with cash dispensers at banks, and a fair proportion of domestic banking transactions are now carried out in this way. We will soon see extensions of banking facilities into new areas such as home banking, and a widening use of credit cards.

The first cash dispensers in the USA were installed in departmental stores. The attraction of the electronic transfer of funds is that the risk of theft and of bad debts is reduced. The popular press has drawn attention to the advent of a cashless society and implies that people everywhere will be affected.

37. THE IMPACT ON STUDENT EDUCATION AND TRAINING

Having established that there are three areas of impact on society, namely those of specialists, users and the public, it is also true that there must be implications peculiar to students studying subjects as diverse as the range of subjects being studied in any college. For that reason a number of areas of particular interest were chosen and investigated in more depth.

38. Semiconductor manufacturers

The report is here concerned with those who design and manufacture micro-electronic devices and closely associated sub-systems. The desirable aims for students in this type of industry were discussed with employers and their views sought.

39. Engineering industry

Changes in the nature of the "electronic building bricks" available (and micro-processors are examples of such bricks) imply changes in the equipment produced by industry at large. Therefore one might well expect changes in the requirements which the training organisations of mechanical and electrical engineering companies make upon further education.

40. The business and management sector

The introduction of cash dispensers has indicated over the past five years the involvement of major banks with electronic equipment. One also finds banks, insurance companies, lawyers and accountants using word processors and similar equipment. Hence their involvement is as users in their own dealings and in their dealings with the public as described in paragraph 36.

41. Stores and supermarkets

It is claimed that the majority of cheque and credit card frauds have taken place in clothiers and departmental stores. Many stores are using a 'white front' credit card operation. (In this a major credit card company and operates the system on their behalf, although only the name of the store is seen on the cards.) They also have an interest in microelectronics for stock control and sales analysis. Thus the impact on the distributive trade will be concerned with their own procedures, as well as their dealings with the public.

42. Public Service Utilities

The effect of their use of electronic equipment upon the general public has already been discussed (paragraph 36). Within the utilities those who have administrative, clerical or technical jobs are most likely to be affected by the introduction of microelectronics.

43. Transport

Here too there is a dual impact, ie on those who operate transport systems and on those who use them. Typical examples of areas likely to be affected are the issuing of tickets and the regulation of passenger flow.

44. Hotels and catering

The training of students for this type of work has traditionally been an important section for further education. Clearly the financial administration of hotels and restaurants and billing and reservations within hotel chains have

been seen in the past as candidates for computerisation. There may be further applications of microelectronics technology, requiring changes in student training.

45. Unions and staff associations

The opinions of those who represent workers in education or in industry are important and no report of this sort can afford to neglect them. However, neither must we forget that any constraints they consider desirable are not necessarily binding on our competitors overseas.

46. Education

It ought for the sake of completeness to be mentioned here that the present position in colleges of further or higher education and the opinions of staff and students will be the topic of a later section of this report.

47. THE CONDUCT OF THE INVESTIGATION

This report is concerned with curricula changes within further education. Students may be school leavers, or they may already have had a (limited) career within industry and wish to be retrained, or they may be unemployed and need (re)training to increase their job opportunities. An attempt has been made to identify separately the educational requirements of those who will be specialists or users as defined in paragraphs 33 - 36. It is acknowledged that this distinction is a little unclear. Nevertheless, we are all, teachers, administrators, students, or others within the FE sector, members of the public and so will be subject to the impact which has been described in 36.

Visits were made to organisations within the areas outlined in paragraphs 37 - 46 including educational establishments such as colleges, polytechnics and universities in the UK and to a lesser extent in the USA.

48. Appendix 2 briefly describes the basis of the interviews held.

PART THREE - PERSPECTIVES FROM ENGINEERING

49. SEMICONDUCTOR MANUFACTURERS

It is the responsibility of scientists, designers and engineers to develop skills which lead to new products which are competitive on the international market. In these terms, the semiconductor manufacturers have lived up to this challenge. Intel in the USA was the first company to bring single chip microprocessors to the market, although the concept of 'a computer on a chip' has been with us for many years. Today there are very many other semiconductor manufacturers who are producing these devices, so that now there are more than one hundred types of microprocessor which are available. Nevertheless, it is probably true to say that there are only four basic families of microprocessor and variants of these types. These are the Motorola 6800, Intel 8080/8085, Rockwell R6502 and Zilog Z80. Most commentators seem to think, however, that the number of competitors in this particular market will radically decrease in the near future. Now it is not the purpose of this report to describe in detail microelectronic technology any further than in the earlier parts of the report; rather one is concerned here with the growing impact it has had, and will be having on the educational service. For example, some manufacturers have seen that it is not enough to expect the educational service to provide scientists and engineers but rather that it is in their own interest to take the initiative of training teachers at school, college and university level to an appropriate understanding of the technology, its place in the organisation of society and its many applications.

50. Schools

One large manufacturer has responded to this viewpoint with a comprehensive 5-day course designed to meet the needs of the new-style technology teacher now appearing in schools. This is, in effect, training teachers who will later present in their schools some appreciation of technology, anything further, say a systems design course, would not be appropriate to school work. The philosophy of the company is that a series of lessons suitable for fifth and sixth formers might influence more good students to come into engineering.

One American manufacturer has specialised, inter alia, in ancilliary chips intended for use with microprocessor-based systems, but which simulate the human voice. Their products, including 'Speak and Spell' and 'Speak and Maths', are designed to enable primary school children to spell, calculate, and recognise shapes, colours, pictures and sounds. Another, 'Touch and Tell' is intended for even younger children. The same company also manufacture a range of hand calculators including some specifically designed for primary school children.

51. Further Education

One problem for educationalists is that as the technology is still changing very rapidly so must the content of any course. For this reason one company has a training department primarily designed to support customers who have already bought products in the training of staff. Also, they train their own company staff. It is this same department which organises the training courses for teachers and lecturers.

Over the last five years hand calculators have become commonplace in the secondary school, further and higher education. Products have become so cheap that few people are willing to service them economically. They are also so sophisticated that it is too expensive for the retailer to train and employ technical staff to demonstrate and sell such products. This situation is likely to get worse as home computers become available more cheaply. The price of hand calculators fell for several years in succession by 25% per annum until they 'bottomed out' with the simplest models at about £4-£5. Equipment prices in the domestic market are set by the 'opposition' as one manufacturer put it, and not by what it costs to make.

There could well be fewer technicians employed in semiconductor manufacture in future, except perhaps in the interface with domestic products such as calculators. This was the opinion of an American subsidiary working in the UK. It would require less skilled labour for production line work but some maintenance would always be required. The industry is very capital intensive and if any manufacturing equipment fails, someone is expected to investigate it, and put it right. The manager declared that, "Education concentrates too much on the details of microprocessor design and manufacture." (There were others

who took the opposite view.) It may well be conceded that the continual upgrading of technology makes the job of the educationalist more difficult. The temptation, he thought, was for other things to be omitted, basic things which really ought to stay in. Regarding the employment of engineers and technicians he insisted, the use of keyboards was as important as driving a car (a skill not usually provided by the state education system in the UK). Everyone should have some skill at this, not necessarily the skill of touch-typing, but a familiarity with the Qwerty keyboard certainly for the forseeable future. This could be realised by lecturers insisting that some essay type assignments be typed by the student, for the declared reason that this gives some keyboard skills.

52. It seems clear that there are different concepts of the work of a technician in different companies. One manufacturer described the work as follows:

"He is a man who is given a logic drawing, who takes it and builds a prototype from it. He must identify the parts he requires and get them, even though they may have different delivery dates. He must work with the purchasing department and obey their rules. He must be able to test the device or equipment once he has built it. He will have various instruments for testing, and he must know the function of them, be able to use them, interpret their readings and understand the principles on which they work. He must then be able to write up a test procedure and get it checked. The diagram must be realised in copper on a printed circuit board by giving the computer aided design team the information they need. He must have an understanding of the different departments in the factory and how they relate to each other, as well as the management structure of those departments. If he is given a low priority in one department and he believes it should be higher, he must know how to override the decision he has been given. He must understand the procedures in the company and on the site."

If a technician had been an apprentice within the company whilst on a part-time further education course then he would have acquired these skills before he completed that course. If however, he was recruited from a full-time college-based course, it was thought that he would require three months to acquire a working knowledge of the skills described.

53. Regarding the recruitment of technicians from school, one company said that they find that school leavers generally know little of industry. The

company looked for attention to detail, and inquisitiveness, which they regarded as highly important. They believed that people should be encouraged to ask questions and that college students should be exposed to the local industry as part of their preparation for the world of work.

This year the company had 80 applications for apprenticeships of which they expected to accept only four on their 4-year scheme. Due to the recession even this was being reviewed. The company had their own examination for the selection of school leavers. People applied for this at the Easter of their final school year. Arithmetic, general mathematics and an essay question were given to all applicants, a practice they had followed for over ten years. They then interviewed the eight best and selected the four from these. Those they accepted went to the local college for two years for a TEC Certificate course. It was then usual for the company to back them for the TEC Higher Certificate, by which time they had finished their apprenticeship at 20 years of age. Alternatively those with merit had the opportunity to go on to university. However, the company were quite clear that they would not give any written guarantee to keep the apprentice in their employ at the end of his apprenticeship, though in practice they had very often done so in the past.

54. It is difficult to be precise about the effect of falling school rolls and the supply of technicians. It may be that the number of technicians required in future will be smaller, but their skills may be greater. This lends support to the view that it is the lower grades of workers whose numbers will suffer most by the introduction of high technology. One manufacturer suggested that it would be useful if people leaving school had a year in industry before starting any FHE course (always supposing they could find a job!) People without industrial experience are often short, he said, on personal relationships skills. Maturity of this kind is most important. Graduates and technicians without industrial experience often fail to realise that people who are not qualified are nevertheless quite able to tell a newcomer essential things about his job. By and large experienced engineers are resentful of lack of appreciation of their expertise.

55. Higher Education

One American manufacturer produces a free magazine about microcomputer progress and products four times a year for the academic community. A pull-out insert invites potential readers to register and so receive the magazine. It includes with each issue a list of recruiting dates for the following year, dates on which a representative of the company will be on a stated university campus to talk to potential engineers with a view to employment. This well-produced magazine contains a number of short articles describing training programmes, training support, new product announcements, book review and so forth. It seems that American manufacturing industry is not limited so much by technology as by the problems of maintaining manpower, such as engineers and software designers. Though this company has a subsidiary within the UK, it does not operate in this way here. Perhaps this is because it is in the USA that much of their main research and development takes place and it is only there that they are interested in the academic community as a source of potential employees. I was told they were inviting college staff to join their courses so that they could acquire course material from company instructors, and use it later in their lectures. It was the company view that its contribution to the US education market was barely off the ground compared with their plans for the future.

In contrast, the manager of a company operating in Scotland said that so far as he was concerned microcomputers were getting the pick of the graduates. He said, "We have no difficulty in getting them; our problem is getting experienced engineers who are prepared to work here". Another manufacturer complained that in interviewing people coming from electronics or physics courses which were college - or university - based revealed that they knew little about signal-to-noise theory, signal processing theory, spectrum analysis or fundamental error rates as applied to digital circuits. It was his belief that the variation between individual educational establishments was considerable, so that graduates from one might in fact be better prepared to work in industry than graduates from another. It was the policy of this company to take very few people without them going on to an apprenticeship scheme.

56. The comment was often made that curricula do not always reflect changes in technology. For example, I was told that the Wheatstone Bridge is often included in the syllabus, but no engineer uses one nowadays. Also, there was so little time spent on things like the basic periodic table and atomic theory. These are at the heart of a good understanding of the properties or materials today. Teachers and instructors, I was assured, still spend time on valves, etc. Comments of this sort may reflect changes needed in curricula, or perhaps the fact that in some cases those who make them are not accurately informed of current educational syllabi and their aims. Nevertheless, what is needed is some re-education of the teachers. Few people come to industry for a job, I was told, with any idea of the basic principles involved in the cooling of electronic equipment, or of chemical principles. People do not know how businesses work, neither have they much idea of the functions of different parts of a company.

57. At one company I was told that one of their biggest disappointments was the lack of conviction that staff in schools had in persuading people to go into engineering; it was quite clear that teachers had little idea of what engineering was about. Careers guidance, they maintained, was often very poor. It is not enough to encourage people in what they are good at. They must advise on what the career prospects really are in these days of high unemployment. It is criminal to persuade young people to go along lines where little or no career opportunity exists.

58. At another company the chief engineer said that the quality of graduates is poorer than it was as little as five years ago. There is so little sign of involvement - none of them are radio hams or amateur constructors or have any appropriate hobby interest. No-one has built his own TV - hence they do not have this feel for engineering that was there so recently. Perhaps there are financial reasons for this, but even at university they only complete one project during the course. Similar comments were made about those joining the company from college-based technician courses. However, it must be noted that this company was relatively small and the number of people involved in forming the attitude of the chief engineer must have been statistically insignificant. It was also at this company that it was stated that students nowadays have little feeling for orders of size or understanding of fundamental principles.

59. ELECTRONIC EQUIPMENT MANUFACTURERS

The companies to which visits were made fell into four categories:-

1. equipment for aerospace,
2. computer manufacturers,
3. electronic instruments,

and 4. electro-mechanical instruments

60. Aerospace

The development of high technology, problems of reliability and the complex structure of companies were three of the reasons given for difficulties faced by manufacturers at the present time. In the first case the pressure to develop new devices and to market them is very great. The fact that an item is being marketed means that it is already approaching obsolescence. Hence when devices are first available it may be possible to obtain them from one manufacturer only. Thus, unless devices can be obtained from more than one source (this is termed 'second sourcing') it could be that the very manufacturers on whom one is relying might only be available on the decision of a foreign government and could be inaccessible in time of political conflict or war. Hence single sourcing is viewed with distrust particularly by aerospace companies who are often concerned with national security and defence. If second sourcing is available this tends to mean that one is not quite at the forefront of innovation.

Another problem is that of engineering design. Colleges have tended to teach design over the years as though it was the invariable intention of industry to achieve the best possible design without any other constraints. In practice, one is very often designing within a given budget.

Another design parameter is that there may be no point in making equipment more robust than those who are required to use it. Nuclear explosions give rise to the generation of high energy pulses. These pulses bombard and damage any complex semiconductor circuits in their path. Consequently at the time of a nuclear emergency, communications might be unreliable just when they are of maximum importance. This effect is termed 'nuclear hardening'.

It has been said that the country which is communicating last wins the war! One way of guarding against nuclear hardening is to make sure that parts which are likely to become useless can be replaced from a store kept in a radiation-safe place. If nuclear radiation is likely to kill those operating a communications system there is no point, it is maintained, in providing supplementary radiation shielding for the equipment.

61. Reliability is of great importance in the design of electronic systems for aerospace. Reliability can be increased with semiconductor chips by reducing the number of manually made bonds which connect the chips with the rest of the equipment, and so minimizing the number of pins on each pack. This however makes testing more difficult, and, hence, testing and reliability may be in conflict. Complex chips can in practice, never be exhaustively tested. (Consider a watch chip for example.) Reliability must be part of the original design philosophy, it must not be left to the quality assurance department.

These considerations are mentioned here because they are typical of the reality of design problems which are seldom discussed in colleges, perhaps for obvious reasons, but nevertheless the engineer in industry must know about them if they affect his work.

62. Emphasis was placed by many engineers on the importance of having a grasp of both software and hardware. It was said many times over and in a variety of different ways that very few people are able adequately to bridge that gap. It was the contention of one aerospace company that more scientists and technologists (hardware and software) would be needed in future, but for their part of the industry at least, they felt they would be needing fewer technicians, since much of their equipment was designed to be self-testing and thus the need for staff to carry out test routines would be less. It was their conclusion that the outlook for technicians in future was more gloomy than for now.

The importance, however, of technician support was stressed frequently. It was said to be difficult to expect such people to be as flexible as once they were, when both engineers and technicians have had to re-learn the subject of electronics so many times due to the pace of technological change. (It is arguably true that this has resulted in people with much wider experience!)

63. In one company there were criticisms of the structures of some companies. Once technicians used to work directly to a professional engineer. Then it was considered that having technicians in various departments gave them a poorer career structure. The result of this is perhaps to have a department of professional services, which takes in the technician work of all the other dpeartments. Career aspirations are probably satisfied better now but this adds a degree of remoteness. It means that what is needed must be written down as a specification and given to the department to implement. Variously the unions, management and particularly accountants were all recognised as being responsible for the shortcomings of this system. Compartmentalisation of this kind, where it has been introduced does not seem to have helped technicians do their work any more effectively. A number of companies expressed the view that engineers were not good at interpersonal communications. They are not as one engineer put it, 'particularly blessed with the ability of persuasion". Hence they do not inevitably command respect in this new set-up. In cases where there is some doubt, this leads in turn to all parties taking refuge in formal situations. It may be that sandwich course students are preferred in industry because they are acceptable to both parties.

Only one company visited made any reference to the ratio of men to women engineers or technicians. The company thought that more effort should be put into getting girls into engineering.

The view was expressed that technicians who are almost solely using large scale integration chips tend to lose any appreciation of orders of magnitude in their calculations. It was also said that they would be digitizing draughting machines both for contouring and for drilling printed circuit boards. Here again the need for technicians is likely to be reduced, and to some extent this may be true of the level of understanding of people on assembly lines. It was confidently said that automatic assembly would be with them in 2-3 years, thus supporting this argument. It was also the view that the acquisition of experienced staff from other companies did not happen as much nowadays as it did formerly. In fact, in one part of the country it was claimed that there were more HND/HNC job applicants around than were required. This was a company which had not yet been hit by the recession. However, they considered that the recession itself was a more important factor for future recuitment than that of

falling birthrates. They were still expanding as a company, though slowly. It was not clear that their management knew whether they would have more people, or whether they would stop increasing numerically and depend on greater efficiency from their existing staff. They were sure that if they continued to expand it would be graduates they would be taking on to a large extent. Already the non-technical staff were falling in number because they were being replaced by computing equipment of one form or another.

64. People in a number of companies wanted to make the point that the teaching of principles is important at all levels, including that of technician. When it came to what were the principles not to be neglected the list became long and there was little agreement of what it should contain. Some of the items were:-

Systems analysis; project definition studies; the use of work packages as a concept; functional partitioning; standard electronic modules; the techniques of breaking down an overall project.

65. Computer manufacturers

The Service Group of computing companies set up a study group in 1978 to examine the quality of the 'graduate' input to the industry. They looked at courses being offered not only in universities and polytechnics but also in colleges. One of their conclusions was that progress in the industry was independent of appropriate qualifications. Computing in the curricula of many institutions was devised in terms of high practical content and relevence. Nevertheless the skill most frequently lacking both at graduate and technician levels was good English usage. This was apparent throughout the range they examined, and especially with operators and programmers. In this sector of industry it was suggested that there were plenty of courses in systems analysis, Boolean algebra, etc., but there were no courses for example in inter-personal skills or contract-management. (This latter term was meant to apply in the man-management sense.) Commercial contracting was also considered to be an important topic.

66. At one company especially, the point was made that retraining was of the highest importance. "No job," they said, "is a forty year project." People must understand that the skills we teach them will be of no use in a few years

time. What needs teaching is the ability to manage these technology-generated changes. Programming should be a larger feature in secondary education. The future of our society does not lie in a struggle between the haves and the have-nots but between those who can and those who cannot adapt to the technology of the day.

Last November the company had to declare over 2000 redundancies. The manpower content of many industrial tasks they noticed had got progressively less. However, only a very few of those made redundant took up opportunities the company had for training. The mobility of many people in practical terms was often very low, and here social attitudes needed changing. This was something that the colleges and schools should have started a long time ago. The company was not very clear, however, why they thought it was the role of education to encourage mobility. Like other manufacturers, they said that what was needed was more vocational training and less education. (Is mobility vocational?) If we are going to have more knowledge-intensive industry then it is important to train for industry rather than putting emphasis on the quality of life. Information, they said was the glue of society. Society could not exist without it and it is, therefore, central to all that civilisation does.

67. Engineers in one company that manufactures mainframe computers, microcomputers and word processors, stated that it was their view that software problems with small machines were nothing like as bad as with large ones. "We badly need engineers", they said, "trained engineers who have good ingenuity, and the ability of putting materials to practical uses." They made the point as many other people had, that 'Star wars' or 'Space invaders' give an indication of how easy it is for young people to acquire skills related to new technology. This should encourage educationalists to channel the abilities of the young in schools and colleges.

68. Electronic instruments

The manager of a company based in the south of England whose business is that of manufacture of equipment for electronic transfer of funds, said that his major concern was the recruitment of software engineers and computer scientists. The supply of them barely matches the demand. They had identified two problems:- One was the number of people in the system, for in the near future the demand is

likely to exceed the supply. The second was the skills they are being given. It is rare, he claimed to find a computer science graduate who can write a tight engineering specification. At the moment there are no degree courses offering software engineering nor are there any technician courses of this kind. It was his view that there would be a large imbalance; those with skills having to work as many hours as they do today. But, he maintained, this would never be a saturation system, for we will always be in a position to create work and markets will be created.

The polarisation between those who can and those who cannot will become greater. Service must not be confused with servility. Therefore, the further education service has a role to play in the re-education which is needed for life skills. (see paragraph 66 for contrary views). Over 90% of the cost of developing software is attributable to people rather than to any other cause. This leaves the problem of how to train the low skilled people to carry out more support functions. This company had their own training programmes - mostly on-the-job training for technicians.

This involved some 20 videotapes of 1 hour duration each. The company used their own staff as lecturers who were not paid and carried out this work in lunch breaks, etc. They also used the Open University Microelectronics Product Development course for those who had a need to appreciate microprocessors.

69. A company in the South East had some 18,000 employees, where 5 years ago there had been 25,000. They made the point that we are short of good engineers who are really committed. We are competing for jobs with people from the Far East who will travel 5000 miles to get one. It is necessary at all levels to attract people into engineering. The higher fees overseas students now have to pay has reduced the competition and means that the pool of skills is lower unless something can be done to attract more people into this area of work. Their major need was to develop software; this work was said to be regarded in the company as secretarial in nature rather than technical.

70. In the industry as a whole, telecommunications was a few years ago one of the last outposts of a heavy electrical industry. They have disposed of large numbers of people who built electro-mechnical exchanges and have trained a great many more on modern systems. They too have noticed that young people,

particularly at technician level, lack personal skills. "They are unaware," they said, "how important each individual is to the system. They do not see the importance of letting us know when they are unwell and cannot come to work, and things of this sort." They thought the supply of software people was beginning to improve. Perhaps this is because people now understand a little better what is needed from the education sector. Software has been a 'buzzword' for too long. It was thought that the industry would get software under control, but it would take a decade to do so. Reference was made to the convergence of technologies, and the fact that the design of equipment involves a number of technologies in one common design philosophy. Thus there is a need for more courses to be interdisciplinary in nature. With reference to the recession it was claimed that morale improves in situations of emergency. Everyone works harder and identifies himself with any success that results. Those who took this line also said that they were convinced that bigger systems, bigger organisations are much better for motivation. (But in times of emergency companies tend to get smaller)

71. Electromechanical Instruments

A South of England company involved in the manufacture of control equipment for machine tools had suffered in the present recession. Money was in short supply and they were having to rely more and more on students attending college in their own time rather than at the firm's expense. They had taken the decision that if people would not do this (or perhaps, could not) the alternative was to hire more highly qualified staff, knowing that they needed minimum further job training. (I received no assurance that this alternative had been thoroughly costed) The problem, they thought, was partly that of the County authority in which they were situated, which they saw as ungenerous and unwilling to award discretionary grants. They thought there was nothing wrong with the teaching of evening students who were in local FE colleges. There was, however, a general lack of practical experience.

There is a tendency amongst girl school leavers who apply to that company for employment with a number of successful 'O' level results, not to want to travel far from home. The training officer alleged they are completely unguided by

parents or careers staff (perhaps parents encourage them to stay at home). Some are so good that they could, and perhaps should do something better. The recession at the present time has meant that this company's customers are not able to keep up a policy of regular replacement of machine tools and mechanical devices are reaching the end of their reasonable life. They thought that in five years time there would be a large demand for a range of microprocessor-based programmable controllers to operate, for example, a production line.

One of the problems identified by that company was that customers are familiar with relays and like to think of systems in terms of mechanical relays even though the system now operates in a different way using microprocessors.

72. Employers' and employees' views

I was told that the practical problems of engineering are not adequately stressed in colleges. Basic engineering information is lacking in 'practical' cases discussed in college. For example, it is seldom mentioned that products very often had to work in electrically 'noisy' environments. A customer is not primarily interested in software, per se, so much as whether it will work reliably in his factory environment. Hence more emphasis should be put on practical problems, particularly for technicians. Another area of importance is public liability, very much an issue of growing significance. New EEC laws are coming in which put the onus on manufacturers to ensure that their products are safe. This does not seem to be part of any course at the present time. Few people have any idea about patent law either. Rather strangely, a Training Officer said that his company are very much in favour of the HND/HNC courses and have people with these qualifications in their employ, they are still uncertain about the standard of the TEC higher certificate and do not think they will have opportunities for employing people with this qualification. (This seemed to me to be prejudging the issue.) They reason that diagnostic work has become automated and hence the job of the TEC higher certificate people has gone. They think that the TEC Certificate students or ONC has a more clearly recognisable role in the company.

73. The views of some engineers and technicians, working in industry,on their own education were noted when visiting companies. One student had taken 'O' and 'A' levels at school and then a degree at a polytechnic. He had graduated in 1976 and was emphatic about the need to keep abreast of current changes in technology by curricula change.

A second student was in his final year of a TEC Certificate course. He thought the course had been very well put together - maths, principles, electronics and computing. Most of his work in the company was in the development of electronic equipment. After he has completed the course he hopes to continue for a Higher Certificate and then for a degree. Unfortunately, however, this will take him to other establishments where the reputation for teaching with his company is not as good as that of his present college. It was his opinion that in some places teaching methods are very outdated. This same studentpointed out that his company five years ago were taking on apprentices and supporting them up to 21 years of age. The company now supports to 20 years. Few people in that company (an American owned one) have a high opinion of training and education.

It was his view that in ten years his work will be entirely outdated. This student again emphasised that more programming is needed in schools, and at college. However, although he thought it important to use Basic as a programming language he emphasised that engineering uses machine level language. Even this, he thought, should be part of school work and the comparable work in FE colleges.

It is interesting that this company had 30 engineers and 10 support technicians for them. It was the view of many engineers there, that the numbers ought to be interchanged. The result of this, I was told, was that if one wants something made, one must either wait about a week to get it, or do it oneself.

The company's engineering manager said that it is important, as he put it, "to debunk the micro" and that people should be in less awe of it. He said that many university students visit the factory; "They all want to work with micros" he said. "Hence the universities are producing people who want to do this. It is easier to program a micro than to design a servo system; hence they take the

easier route." It was his opinion that this applies to technicians also. "Basic theory is displaced for window dressing" he said. The message he wanted to get across was that microprocessors are not very difficult, but are an immensely powerful tool - there is no magic about it. The media are to blame for thinking there might be! Using a calculator, for example, means that one can perform calculations in greater detail - not that, in fact, one does them any quicker.

The future of technicians, he thought, is not as bleak as that mentioned in other companies. People change the names of jobs and though sometimes people do call themselves 'engineers' they are doing the work of technicians.

74. Amongst the items which it was thought by students of a European Company could be omitted from higher TEC courses, are electric motors, and heavy power engineering, with less e-m theory. Instead they asked for more linear circuit design, using integrated circuits. The variety of response from industry must be regarded as a warning to avoid rash recommendations in this area.

PART FOUR - PERSPECTIVES FROM THE BUSINESS AND MANAGEMENT SECTOR

75. The B & M sector is of particular importance in this project because changes taking place there will affect the great majority of the community who handle cash. Systems for the electronic transfer of funds and the use of word processors are of particular significance.

76. THE EQUIPMENT

The equipment in use in this sector includes automatic teller machines (or financial terminals) operated by bank tellers, self-service financial terminals, cash dispensers (known in the USA as automatic tellers) operated by the bank's customers, point-of-sale terminals and word processors.

77. Word Processors

The significance of the development of word processors is a very good example of the premises which led to the development of microelectronics technology itself. The deployment of more sophisticated electronic equipment has tended to make business capital intensive, so as to increase the productivity of those employed and so reduce dependance upon labour which has become increasingly expensive. The real significence of the rapid development of word processors is that they exchange some of the cost of secretarial staff for that of equipment, and thus bring about a substantial economy. The cost of word processors is falling at the rate of 10-15% per annum in cash terms and in real terms the fall is clearly greater. This has been brought about by large manufacturers who are employing increasingly large production runs. They themselves depend on high technology and are relying on wider acceptance of de facto standards, eg the IBM floppy disk standards and the ISO character set, to increase their sales.

78. Point-of-sale terminals

A point-of-sale terminal is a development of the cash register designed to carry out a number of essential functions as well as to receive cash or register the receipt of credit card vouchers. A terminal is usually part of a network of similar terminals with a central control system. It is estimated that about 95% of all payments over 50p made by individuals for goods and/or services are

made in cash. Cheques account for 3.7% of these payments. Therefore, the potential to replace cheques is small compared with that to replace cash. This is the basic argument in favour of the introduction of point-of-sale terminals (POSTs).

There are two types of POSTs:-

1. High turn-over POSTs, used in areas with a volume cash register business, but primarily as an input device to a stock control system.

2. Cash receipting POSTs, used to reassure the customer that he knows clearly where his money is. They are used for centralised stock control in the retailing of shoes, clothes, DIY, jewellery, etc. They are also used as office equipment in the sale of high value items, but this is still largely an unexploited market.

79. Types of terminal

There are two types of microprocessor-based systems used as terminals:-

1. Unintelligent systems (in the USA termed 'dumb' systems) - have an internal program which is invariable. All 'intelligence' is concentrated at the network centre.

2. Intelligent systems (in the USA termed 'smart') have variable internal programs; that is, processing is carried out at the terminal.

80. Transaction terminals

There is a range of equipment known as transaction terminals which includes terminals for credit card validation, and currency exchange terminals (as in terminal 3 at Heathrow) and which are operated by bank staff. Transaction terminals are also used for the purchase by credit card of tickets from airlines, railways and coach organisations. A signature verification terminal is also technically possible but is not known to be in use at the present time.

Somewhat similar is the proposed terminal for Immigration Control for use with the new Europassport. The identification characters on this 'insert' in a national passport are optically read and then compared with known lists of people whose whereabouts are of interest to Control. Most banks have thought about is application in point-of-sale terminals, but experiments in the USA with this mode of operation have not been successful and terminals have now been withdrawn from most stores.

81. BANKING

Self-service financial terminals (cash dispensers) have been in service in the UK on bank premises since 1976. These terminals offer the customer a number of alternative services including balance enquiry, statement demand, cash, and the opportunity of ordering a new cheque book; in some cases they will accept an input package, perhaps containing cash, for later manual verification. In addition to this a number of special functions are provided for the bank. This may include a magnetic tape cassette to provide a means of loading terminal programs and also a 'hot card' file. Automatic (often on-line) data capture is provided.

82. Home banking

Banks have their own Viewdata systems compatible with Prestel but they are still in an experimental stage and not yet open to the public. In fact, one bank at least is experimenting with the use of the human voice as an input medium to their system, although this may be technologically premature. The use of Prestel as a 'gateway' into a banking system leads immediately to the introduction of home banking. The intention is to replace the use of paper by electronic funds transfer and the authorisation of every transaction. There is substantial demand for this service from customers, especially since banks are no longer open to the public on Saturdays. The further 'down-market' one goes with cash dispensers or with POSTs, the worse the losses seem likely to be. Hence the use of plastic cards to minimize losses.

How banking has already been brought into use in West Germany and a pilot scheme has been run in the USA. Two banks are at present involved and one more will soon be joining them, using the West German Viewdata system. Home banking there is used to make a number of payments (rates, telephone bills, etc) and one can

see a statement of one's account or transfer money from it into a deposit account. The 'gateway' referred to provides access to a commerical computer, so that one is going into the national Viewdata and out again via regional telephone circuits, often eliminating the cost of long distance calls. However, it was the view of one bank in the UK that here shopping from home might come first, (there is an experiment with this in Newcastle), although this has not been the case in West Germany. A number of mail order companies were mentioned as likely to be interested in such a scheme.

83. Use of credit cards

One British bank is operating an experimental scheme known as Counterspeed, with six garages in the Norwich area. Each filling station uses a free-standing computer terminal to enter details of the bank's credit cards offered by customers when purchasing petrol. Magnetic tape casettes are used to give information of transactions daily to the bank's computer. One of the bank's problems has been to secure the co-operation both of their customers and the service station managers. The bank now offers a guarantee that they will honour any transaction made in this way. Nevertheless each filling station has a few 'hot' card numbers for which they have to keep a look out. The bank is not surcharging the stations since they themselves are supplying all the labour needed to access the computer. The manager of one station said that 17% of his business is now with credit cards.

Asked whether he would be happy for the scheme to continue indefinitely he said he would lose more by not continuing than by carrying on after the experiment had run its course. Each transaction takes about 16 seconds which is much better than say, one minute for a cheque or 30-40 seconds for a credit card transaction without the terminal.

Credit cards are often used by retailers to promote business or to try to keep customer loyalty. Most of the long standing cards are administered by department stores or by hotels themselves. A more recent development is that of contracting the complete operation to an established card issuer such as a clearing bank or credit card company. This is usually termed a 'white front'

operation. Administratively the card is treated as if it had been issued by the bank or credit card company, although the card itself carries only the name of the retailer or hotel chain.

84. Distance learning

One bank is known to be looking into distance learning using microcomputers. The intention is that, since terminals have been installed in any case, it might be possible to use them for distance learning for their own staff. They have found that young people recruited directly from school do know a little about computers at the present time. Also, their staff are required to use VDUs and terminals as part of their daily routine, so distance learning might be a suitable mode of study for new staff. But the personnel department head of one British bank commented that there is no evidence that it might have importance at management level also (contrary to the view of a New York banker). He also said that attiude changes take a generation to get through, particularly at senior level. Nevertheless, for the majority the basic skill which is really needed is experience with terminals: to get this the bank is prepared to do the necessary training themselves.

85. Future developments

In the UK just over 50% of the adult population have a bank account, but no bank has more than about 27% of the total business. Hence on the one hand it is hardly economic sense for one bank to go it alone on any venture, but on the other, should one bank do so, the others might feel bound to follow. So far as POSTs are concerned, they are expensive to set up and it is difficult to get retailers to take a share in the cost. The main opportunity in the personal sector of banking lies in the possibility of large numbers of wage-earner accounts being made more profitable for the banks through the introduction of automation.

86. Banking and education

Asked whether school leavers being recruited at the present time have an acceptable knowledge of computing operations, one banker said that it was his bank's policy to recruit school leavers with varying academic levels of attainment and develop their technical knowledge with their own in-house

training. It was not his opinion that school leavers need to have other than a fairly superficial knowledge of computing.

Asked whether in five years time they thought it would be possible to recruit people with a knowledge of the more sophisticated technology which would by then be in the bank, the reply from banks was that they would expect the various educational bodies to do what they could to keep abreast of the needs of industry and commerce. Nevertheless, they saw no need to change their existing approach, bearing in mind that their own recruitment and their own training procedures are subject to continual improvement and review.

87. Banking in the USA

Bankers made the point that they run two types of business; personal banking or consumer banking, is far less profitable than their other business, corporate banking. Hence they are having to try to change the structure of consumer banking. One way in which this is being done is by using automatic teller cash dispensers. They have been in use in the USA since 1974. At the present time one bank said that they alone had about 800 machines in 300 locations in New York state. In addition to the functions described in paragraph 81 some dispensers include the purchase of travellers cheques.

In the USA the total sum of savings deposited throughout the States is huge; there is no single bank which has any significant proportion of it. There are 14,000 banks in the States which have federal authorisation and deposits are spread very diffusely amongst them.

88. One banker told me that his bank thought that the changes taking place in the cost of fuel, especially petrol, are particularly significant. Because of this there is a tendency for new patterns to develop in the ways in which people spent money. Such new ways do not involve the use of petrol, etc. The purchase of electronic equipment was one example. He pointed out that this implies a development of video recorders and electronic games through to home computers. He was sure that Apple computers, for example, could do home banking now, but there are still not enough home computers to make it worth his while to go into home banking. It was his view that the number of customers with computers will grow steadily until at some critical figure when all this will

come in suddenly. In contrast to this bankers in the UK who have the advantage of Prestel have no need of any other equipment. (Viewdata systems were not current in the USA in Spring 1981.)

89. At one bank I was told that they are using word processing but very few word processors are used for mail within the bank. They thought it is technically possible but its significance is rather minor. However at another bank they said this will be an important future development. It is related to the cost of postage. When postal charges rise beyond a fixed figure in real terms (and postage in the USA costs much less than in the UK) then there will be a move into electronic mail. This will mean that the conventional postal system will suffer a fall-off in use and that it will then be less efficient. There will then be further price increases, which will cause more people to move into electronic mail, so that at some critical stage this might be sufficient to cause a radical reappraisal by the postal authorities. "We are not limited by technology," he said, "but by social forces."

90. The use of word processors in other connections is developing with staff over a wide range of grades. One manager told me that it is his intention to defer the filling of posts with secretaries who could take shorthand notes. Already all his secretarial people are using word processors and he wishes to bring these in as executive terminals (or work stations) also, since they can improve the quality of reports and other executive tasks. He felt that where a manager can turn to a secretary to take notes in shorthand he will do so, and it is only by eliminating this over a period of time that he will be successful with the introduction of executive terminals. In another case I was told of a senior executive who has such a work station but has no intention of using it. Neither will he give it up. It is a status symbol.

The writing of reports is made much easier with a word processor and it was the view of one banker that most people are not good at writing at length, so skills of this sort need to be acquired. "This accounts," he said, "for the telephone being considered as ideal for communication but text devices are much less popular."

91. Regarding training for new technology, it was clear that most banks have their own system, sometimes using organisations outside the bank, particularly

for software and computer languages, but more often doing the training in-house. In one case I heard of a three-months full-time course on basic systems including an introduction to data processing, Cobol and IBM mainframes. The bank are about to break the course down into a number of modules so that existing employees can take only the modules they need. A newly recruited trainee would start from the beginning and take the whole course. This, I was told, is typical of the training in terms of content which they offer to newcomers to their staff. Typically they have 20-25 students on this course at any one time. It was quite clear that there is a considerable amount of in-house training going on in banks in the USA. One of my informants was a bank Vice-President who still takes training modules from time to time to keep up with new developments.

92. ACCOUNTANCY AND LAW

The use of microprocessor-based systems and word processors is well developed in this part of business. These organisations are prime examples of where standard documents and letters wanting little modification are a regular requirement. In addition, for accountants, there are monthly accounts, statements and trial balances to be processed as well as stock control and billing. It is typical to find microprocessors being used with floppy disks, each disk being secure for a particular client. Though often duplicated, security was improved by having the two disks kept in different places. One accountant said he had firmly decided against operating a payroll as part of the service to customers, where this could be computer controlled. He said that this leads to a great deal of unprofitable time being spent with employees and does not help his relationships with his clients.

People in these organisations felt that they expect students leaving college to have some knowledge of word processing and some hands-on experience, but that it is unrealistic to ask that they know about a particular processor.

93. INSURANCE

The manager of one large company said that 93% of their indoor staff of 6500 come to them straight from school and only 3% from university or college. Of

the field side of 16,000 people none of them nowadays starts with this company under 22 years of age. Their selection procedure, he said, means that out of 20 application letters 10 people are interviewed and he ends by taking perhaps two of them. They particularly looked to see whether applicants are enthusiastic with a reasonably good general understanding of life. But they find that they have not been taught much about what employers in fact want, or about the world of work. He expanded this by saying that employers are anxious to see new members of staff accept the discipline of the workplace. He felt that the education system has not come to terms with the transition to work. Students have seen 'Tomorrow's World' and tend to have too optimistic a view about technological back-up. Nevertheless, it later transpired that the company has 900 people on day release to 21 different kinds of course. Even so, I was told, it is their opinion that if a company of their size, has a training need, they can very often run a course of study internally; and this they do. He said that they themselves do remedial work in English and mathematics and spelling and "in all the fundamentals." The company does not pay for books on outside courses, but gives loans to staff and time off if the study is relevent. There is also a cash award at each stage of success. At the end the students get a salary increase which helps them, he thought, with their career prospects.

94. Another large company has 350 people working on one site to the south of London. This includes 100 programmers and 65 systems analysts. They said that they tend to train people themselves in most areas of work. When the personnel department are hiring clerical staff they prefer to take girls from school, preferably with typing experience, since this helps with keyboard skills generally. There is already in the company some prejudice against using trained secretaries who do not have experience of word processing. He thought this attitude likely to grow. The company had had difficulty earlier on, in training people themselves, and it had taken a long time to turn round the typing section into the use of word processors. It was their opinion that full capability with word processors takes a long time for anyone to acquire.

This company has a UK training divison in London which looks after the branches. There could be some criticism within the company, of the company's management, for allowing word processors to develop haphazardly, rather than have a

company policy. The way this had happened, I was told, is not typical of the company's methods. They had been caught off guard. (There is perhaps a lesson for others to be learnt here.)

They had come to the conclusion that they prefer to do their own training of programmers, unless this proves to be decidedly uneconomic. It was their preference to take people who are without experience in the business world. They are just about to start their first Systems Analysis course for people who have had five years experience, preferably in their company but in some cases obtained elsewhere.

95. Insurance companies are in the mortgage business and have been so for many years. Banks and building societies are moving closer together in this role, mainly due to the custom of building societies being open for business on Saturday mornings when banks are closed.

They said that some of their agents have computer terminals in their homes linked to their data base but with access restricted to a limited repertoire. They thought that their agents are in favour of having this facility since it seems to give them an edge over some of their competitors. In any case this line of action is being forced on them by growing competition. They thought that this sort of reason would bring in new systems rather more quickly than otherwise.

PART FIVE - PERSPECTIVES FROM STORES, HOTELS AND RESTAURANTS

96. MULTIPLES AND DEPARTMENT STORES

At the headquarters of one multiple store which has 220 supermarkets and nearly 40 other outlets and a number of hypermarkets, their use of technology is largely based on an ICL 2926 mainframe computer. This company is also one of the leaders in this country in the use of bar coding.

A report from the Federation of German Industry (the West German CBI) says that this is not the best way of marking goods in supermarkets. In view of the cost of bar coding systems and the fact that it does not replace price coding on the product itself, they recommend that it should not be used. (Does this seem to be going aginst the tide?) In America bar codes are called universal product codes (UPC) and are used primarily in supermarkets and discounts stores but not in high quality departmental stores.

At each store in this group, stock control is carried out just before closing each day, by the staff touring the shelves with a portable data logger and a light pen to read the bar coding. The operator keys in the number of items needed as each variety of item is read. This is recorded on magnetic tape and is polled on a telephone line overnight from a central computer. The computer then prints out at each distribution depot the requirements of each store which that depot services, for delivery that morning. The same computer carries out stock control at the depots.

97. The Personnel Manager at the company said that this has taken the boring part out of the job and also given the people concerned some job enrichment. It seems also that it has cut down on the staff requirements of the company.

They are now running a pilot scheme with five stores, one of them at Crawley Sussex, with low power laser operated check-outs to read the bar coding. In this way the print-out which the customer receives states not only the price but briefly describes each item on the tally of the goods he has bought. The company has compared the takings from such check-outs with those from similar stores in the USA and are very satisfied with the results. Also the branch management have an analysis of sales. I was told that it will be some time

before the data obtained in this way can be used for restocking, but no supporting arguments were given for what seems to be a simple extension of the scheme. The speed at which customers pass through the check-outs is increased in these stores and the till roll is easier to read, leading to greater customer satisfaction.

98. This company is also involved in a government-funded experiment on the total electric power used in a store (light, heat, refrigeration, etc.) This is a microcomputer control project and looks at the ways of transferring as much load as possible into low cost periods.

The company has recently introduced word processors for part of their Headquarters' staff. They formed a working party of six people, including some of the secretaries who were going to use them. They visited manufacturers and other companies already using the equipment. Considerable efforts were expended to obtain the co-operation of the staff. Later, a company policy statement was circulated confirming that it was not their intention to set up a word processing centre. It was also decided not to create a special grade of secretary, but instead, word processing was to be considered an extension of existing skills and an integral part of the work of a secretary.

As a result of their investigation they are now using stand-alone systems so that anyone can use a word processor by a booking arrangement. In one department there were 13 secretaries and the four oldest stated that they did not want to get involved in training. They now continue their former job. The nine who were interested attempted a familiarisation course and three of them showed extra aptitude. These three were then trained more fully than the other six. It is interesting that the three showing extra aptitude were also the three youngest of the group.

99. The manager said that they will only be interested in future in hiring secretaries who are as familiar with word processing as with typing. Shorthand, he thought, will still be in use for the next five years for their more senior secretaries. The girls in this experiment started off being afraid of the implications of the new technology for their job security and the company took great care to overcome this. Perhaps they had good reason, for in ten years the volume of cash turnover of the company has increased by 75%, but their staff by

only 5%. They are planning to open 150 more supermarkets in the next ten years. Checkouts will, I was told, need to be manned by brighter and more intelligent people. Now with laser checkouts the girl faces the customer and they feel that they will have fewer, better people who will be paid more for this work.

100. At the Headquarters of another multiple company I was told that in 1966 they had 26,000 people employed with 34 people in a central wages office. There was a manual pay room and additional staff at weekly peak periods. Now in 1981 they pay 52,000 staff including 18,000 full-timers, 28,000 part-timers and 6,000 pensioners for whom there is now a company pension. Store management has been relieved of much management record keeping and there are now only 14 people in the central wages office. The job they now do could not have been done manually without a large increase in the earlier staff. Computing has saved them this. This company, which is well known on high streets throughout the UK had a very conservative approach to new technology. They had only owned computers for three years although they had used them for longer. They were rather cynical about the ability of electronic equipment to do better what was being done by other means or by their present computers. For example, they took the data of weekly sales per store at the end of business on Saturday and prepared statistics from them manually and stated that they were always on the Chairman's desk by the following Monday morning. They used this to illustrate that there has to be a proven advantage if new methods are to be used.

They said they are unlikely to adopt the use of POSTs since they are not involved in areas where they are most likely to be introduced. Senior staff held the opinion the POSTs will not be available at any time during the 80s. 31% of their takings are by cheque and as this grows they intend to change their present central acceptance of cheques, and they will no longer be dealt with at one central point in the store. This may, however, very well give the banks reason to introduce POSTs as described in part four of this report.

101. In that company word processing was not envisaged as a technique they wish to employ. They felt that, despite the large number of stores that they have, there is no need for electronic mail, since they deliver mail to and from head office and branches, along with new stock, overnight.

Regarding their opinion of the educational provision, they held that there is a remoteness from the real world in the universities, but their experience of the further education sector is better. Where unemployment is prevalent, they claimed that they can get high quality staff. For them numeracy was important, even more important than literacy. High moral standards, like "Thieving is wrong" are important. "People here are well paid, but we expect a high level of discipline from them."

102. Stores in the USA

Experience in visiting stores in the USA was rather different. There POSTs are used extensively. Credit card numbers are keyed into the terminal and authorisation received back. In one store, rather up-market, they only accept their own cards and American Express. This they claimed has proved successful since they were first introduced in 1974/5. The reason why they operated in this way is to attempt to retain customer loyalty, that is, to keep people in the habit of shopping at their store. They were anxious too, to obtain merchandising information such as selling volumes related to time of day at which sales are made, so that it is possible to obtain a profile of the productivity of each register spread over the day or week or month, and to compare the productivity of one register with another.

103. One store had a new sophisticated operating system for goods coming into the company. They enter data on a VDU using a keyboard in the actual receiving bay. This forms a basis for the payment of invoices. The system is tied to their central computer so that payments are now made automatically.

Over the years their sales force has changed due to natural market changes, so that their average age today is much less than formerly. At the back of the house, staff are given opportunity to retrain on the principles and practice of data processing with their system. Selling is no longer considered as a career in the USA like it was years ago. No one there appears to be anxious about new electronic systems, but nevertheless the sales staff join the store for a few years only.

104. At another store, somewhat more down-market, POSTs are also used for training new staff using POSTs linked to the store's mainframe computer. Word

processing in their offices is, so far, entirely absent. This store is prepared to accept a wide range of credit cards, one of which they issue themselves. Validation here also takes place at the cash registers. If there is any doubt or validation is not easily forthcoming, there is an office to investigate dubious responses. On further questioning, it was confirmed that this implies that the cash registers go through the store's computer on-line to the local credit card companies' computers. Regarding the wide range of cards they accepted, their comment was that they wish to make it as easy as possible for their customers to shop there. The risk is that by accepting these cards they might attract people away from their own card, but over the years they have found that this does not happen.

This store recruits from school leavers to near retirement age. They run into part-time staff on a large scale. I was told that it is sometimes difficult to find day-time staff; casual staff for evenings and weekends are a lot easier. Stores at the present time in the USA East Coast cities are going through a tought time, and some long established stores have gone out of business.

Regarding training with this company, it seemed that they do a certain amount of training on POSTs for sales floor staff. They produce executives and buyers' manuals for senior staff and they expect newcomers to take them home and learn their contents in their own time. They have little contact with colleges which correspond to our further education system, when seeking either shop floor staff or executives.

105 — HOTELS AND RESTAURANTS

It is quite clear, reading articles in the catering press, that computer systems and microcomputers in particular have already made substantial headway in the large hotel chains and are now being pressed on small businesses also. Trade organisations, too, are doing a great deal in this connection. In the UK over 80% of hotels have a restaurant attached, whereas in the USA this is far less common practice. It has been said that the management of no two hotels is alike. Hence is seems reasonable to expect that time and effort is needed to design computer software appropriate to any establishment. It is important to ensure that the cost of this effort is spread over as many users as possible, so that the cost for any one user becomes more acceptable and the introduction of a

microcomputer is cost-beneficial. Particular applications in hotels are guest accounting, general accounting, payroll, catering control, bar stock control and reservations. Software houses are already offering packages for these and other options. It is important to obtain control information very quickly because of the danger of pilfering and it is often found that about half a day per week by one computer operator can handle most of the work a small business needs. The need for accuracy in stock control is a concept everyone should have.

106. Turning to the larger hotel chains, one company said that they have a central reservation service which until recently has been operated on a telephone enquiry basis. Now a computer with terminals and VDUs in their hotels exists and is being commissioned at the present time. At one of their London hotels a new telephone exchange has been installed based on the use of microprocessors. Memory facilities, with guests preferences and the telephone numbers they are most likely to require ensures that guest dialling is simplified. Print out and charging are part of the system so that items are added automatically to the guest's bill. Hotels have provision for drink dispensers (mini-bars) in hotel bedrooms. A coded room door and dispenser key has been introduced at one hotel, in appearance rather like a cheque card with magnetic stripe, and the key is recoded when the guest leaves. Changing lock codes is an important feature, and indeed the system was originally commissioned for security reasons. These code changes are made centrally and not at the room door, each time a guest leaves. This arrangement is helpful in preventing intruders gaining access to rooms and reducing the losses which many companies suffer when guests make last minute long distance calls which otherwise might not get charged before leaving.

107.The question of introducing Prestel as a facility in bedrooms has been investigated by one hotel group but they found it difficult to assess and allocate charges and are convinced, after an experiment, that the present charging tarriff makes the system unattractive.

Another company which operates a chain of coffee shops has a system by which orders are made out by a waiter on a keyboard and transmitted to the kitchen. This, I think, is unusual and not a widespread practice. A few companies are experimenting with the use of microprocessors as a control system in cooking. It is hoped to bring this in for certain fast food operations, such as motorway

service areas. Microwave cooking is commonly used in such situations. But there are problems connected with flow of raw materials. The tills used in motorway service areas are now usually microprocessor-based for ease of sales analysis. There will be a tendency in this industry to try to achieve more accurate stock control and management information.

108. Receptionist training is now carried out in some cases using a VDU in reception at quiet times of day when new front office staff might otherwise be idle. In five years time this could be much wider spread. Personnel staff are surprised at the low levels of numeracy even from graduates who join them. "This," they said, "limits our potential for analysis tasks more than any other cause." Literacy and the use of English are very poor amongst new recruits to the industry. They are perplexed about how to correct literacy difficulties, whereas numeracy problems they can do something about.

Another slightly different aspect of training is that receptionists have to 'train' their guests in the use of some of the new technology that is becoming available. For this reason it was the belief of one company that personal skills will become more and more important in reception. With the advent of falling school rolls they will have to concentrate particularly on techniques for improving the social skills of those they employ.

109. Recently staff in one hotel chain has been cut ten per-cent without specific areas being closed. Hence they have got rid of some part-timers. They argued that the tourist sector will improve before the rest of the economy and they are looking on this as a key sign for the upturn. They said that only when they can see profits being lost will they increase the number of employees again.

110. It seems fairly general that word processors are only just beginning to become part of the normal scene in hotel offices, whereas it might be thought that there are specific jobs associated with hotel operations which would encourage their adoption. Small systems in use in coffee shops have the advantage that they can be made capable of menu analysis also.

One company told me that they are about to computerise the four main hotels in their chain in London. Depending on how this goes they will consider the

remainder. Hardware is no problem since they have connections with the electronics industry and also they have their own Management Services division which vets things of this sort. I was told that there is some conflict between management at Board level and those responsible for input; and that this has hindered development. There is a suspicion that departmental supervisors do not like too intelligent people! There are many people still around in the industry who were there 15 years ago when catering was not thought of in some quarters as a reputable career opportunity. Such people do not like college graduates and are envious of their ability. When they retire however in 10 years say, the position may change very dramatically.

Comment made here regarding potential employees will be of value in all sections of this work. In the catering industry the first impression a person makes, is so very important - how one is dressed, knowledge of the English language, time of arrival for an appointment (neither more than five minutes early nor three minutes late for example). Culinary French can be taught on the job, but personnel staff at a number of company headquarters commented that they spend a great deal of time finding out how good one's English is.

111. "The keyboard skills needed" it was explained at one hotel, "are basically numeric; anyone can learn to type. It may take time to type in information but the new technology is faster, so that overall it does not matter too much if the staff are slower whilst still on the learning part of the curve of an installation." Different skills are now needed. More important are personal skills since there is now more time than was once had, to write down the full information when guests register, for example, or in taking a restaurant order. The manager had expressed specific problems previously about the limitations of computers. So the technique this hotel group uses is to start training new front office staff with an induction by a training offer of one half to one day, at which a terminal and VDU is demonstrated and a couple of programs run through. Then they are on the job alongside an experienced clerk. One of the prime reasons the group had for going for computers was that it is claimed that they dramatically reduce the induction time in clerical tasks in hotels. Hence, the training officer said that when the economy recovers and staff are harder to get, he will be content with lower grade staff provided that their attitudes to clients are satisfactory. Most hotels duplicate their computer records as a safety measure in case of catastrophe.

112. A survey has shown that the number of microcomputers in use in the hotel industry were 274 in 1976, 44,510 in 1979 and 440,000 might be expected by 1984 at this rate of development.

The Training Board for this industry has issued a guide on small computers (in 1981) which helpfully explains their applications in catering.

Self motivation is very important in the catering industry and where this exists it carries over into business. People who have good 'A' levels are clearly right for a degree course; for the rest, touch typing is essential for some people, for example receptionists, but hardly for chefs. Some appreciation however, of microcomputers is needed here too. Some of this will be done in schools and we should place more emphasis there. Computing must be separated from mathematics so that it can develop more quickly in its own right. The Training Board are known to think that there is a big future in computing in management training, not as an example of computer assisted learning but as a management tool. It helps people's own thinking.

113. In one company I was told that the Technician Education Council (TEC) Diploma in Catering ought to contain a unit on computer appreciation. This would provide experience in, for example, the use of a keyboard by a waiter to the kitchen. At the moment there is a not a skill deficiency, but in the future (perhaps in five years time) there may very well be one.

PART SIX - PERSPECTIVES FROM THE PUBLIC SERVICE UTILITIES

114. This topic has already been broadly treated and the impact of microelectronics on a wide range of public services: (public transport, electricity, gas, telecommunications, etc.) has been examined with reference to its implications for society in general as well as for further education. Throughout this report the anonymity of public companies and those representing them has been maintained wherever possible, but in this section where services are very often monopolistic in nature, the organisations concerned are usually named.

115. PUBLIC TRANSPORT

British Rail operates in a way which brings it in contact with many of the applications of microprocessors. They have, for example, the largest private telecommunications network in the country. The new role of British Telecom (formerly Post Office Telecommunications) comes at a time when very much of BR's equipment is still old fashioned and needs replacement. At the present time they have only one electronic exchange and as others come up for replacement, equipment similar to Systems X is bound to be envisaged. There are also problems of maintenance and of reduction in staff.

Since their system operates on their own land there is potential for the use of fibre optics. They are setting up a pilot scheme in the near future which if successful would mean that the system would develop rapidly.

Facsimile is used at present by BR for staffing operations and letters. They already have a few free-standing word processors and are installing some shared logic systems with communications capability. This will naturally tend, in course of time, to become a private electronic mail system.

BR expect to be recruiting fewer technicians in five years time and many fewer in ten years. Technicians will have to be better, more skilled. The advanced passenger train is an example of a system in which microprocessors are used for diagnosis. Automatic fault diagnosis implies less manpower, as in some cases all that is needed is replacement of modules.

116. Electronic ticket vending machines are being developed and will appear in service within the next 12 months. One system operates with bank credit cards. But it is BRs opinion that most ticket vendors will be operated by their own staff rather than by passengers. Credit card readers and validation will be part of ticket issuing machines at main stations. Portable ticket machines of a new type are coming into service, used by guards on paytrains, which involve recording data on magnetic tape. Microprocessor-controlled cash registers on Sealink cross channel services are now used to record sales. They use a tape casette so that a trading account of sales on a voyage can later be completed automatically. For this to be carried out the casette is discharged on-line to a BR computer on reaching port.

117. Sealink have 250 frames on PRESTEL (see paragraph 135) and BR have contracted for 1000. The ABC guide is also on Prestel. Like many other organisations, they are looking at Viewdata analysis in connection with updating the data they display. At the present time Prestel is beginning to increase its early very modest rate of expansion. All BR timetables will be internally on computer by 1983 and in time this will interface with the passenger information systems at stations. This clearly has significence for signalling systems generally and the new Victoria signalling system on Southern Region involves microprocessors.

118. BR support many day-release and sandwich courses at further education colleges. Their opinion was that they are in general satisfied with the work that is being done there. One point at issue is the ability of people to write reports. They thought that at 16+ some spelling and report writing could be improved. In all fairness they pointed out that this applies to school leavers from both state and public schools. BR said that they recognise that they are competing against other parts of industry and in some cases stand little chance against them, due to salaries and prospects with BR sometimes being less attractive. However, they thought that the people they do have frequently show a very high degree of motivation.

119. British Rail Engineering Ltd (BREL) is the fourth largest engineering concern in this country. They comprise 13 'factories' from Glasgow to Eastleigh, with 30,000 staff. Their job is to manufacture and maintain the rolling stock of BR. Each year many millions of parts are manufactured using

machine tools of which 90% are numerically controlled. There is a computerised system for their stores (the store at Derby is automated and serviced by trolleys) and they are introducing further terminals with VDUs for stock control. It is their experience that anyone on the shop floor can take to the new technology. They said that they see no problem with keyboards since no-one needs to operate at high speed and codes are used rather than plain language. They regard this as one aspect of on-the-job training. The introduction of computers into schools has already taken away much of the fear of using electronic equipment at work. For BREL the recruitment and loss of computer programmers is not a worrying feature at the present time. Perhaps this is because their system is unlike that in use elsewhere. They do their own training and the turnover of staff is small.

Their technician training scheme has its roots in the craft grades. It is difficult for BREL in their business to take on technicians ab initio who have no craft background. So for the major recruitment of technicians they mainly use the people who started on craft courses and showed promise. Nevertheless the quality of their technicians on TEC courses varies throughout the country. The problems are more likely to be due to individual colleges, they thought, than to the TEC general engineering scheme itself.

Regarding the problems which they are meeting with their technicians, they claim that literacy and numeracy problems head the list. It was their contention that imperial measures ought to be taught as well as metric since both are very much alive in their business, particularly as at least 10% of their production is made for export (presumably to countries using imperial measure). This is also true of the rolling stock which they are refurbishing for BR. It was their opinion that it will be at least the end of the century before one can safely say, "Teach only metric."

The attitudes of technicians have become a greater problem nowadays. The young people who join BREL today, they maintained, are not as communicative as they used to be. They are conditioned by 'the box' which does not require a response. Early marriage was also pointed to as a cause of reluctance to continue with study. BREL has experimented with residential courses so arranged that people are thrown together in groups, perhaps with reading material (eg on motorbikes) to stimulate group discussion. To summarise, it seemed that BREL

discounts problems associated with the introduction of microelectronics and are more concerned with problems arising from social factors.

120. Transit systems in the USA

The Greyhound Corporation is a company with some 90 subsidiaries, whose business includes the manufacture of buses, transportation, food and food service operations, the manufacture of soap and detergents, and associated finance. The interests of the organisation are world-wide. It was clear that, at their headquarters in Phoenix, they have gone in for automation to a high degree. They have 2000 people there including some staff of their major subsidiaries, out of a world staff of about 52,000 people. They have, for example, a number of stand-alone processors, but they are the exception rather than the rule. They are used where there is some positive motivation such as security. Normally they have systems handling up to 31 devices (printers, keyboards, etc.) interconnected by coaxial cable. One major use was their assessment of legislation in cases of losses where the company was being sued. They also had a private switched network for communications with some 150 stations. Electronic filing is used with either hard or floppy disks.

Each stand-alone word processor costs the company $5000 per annum. With word processors, a clerk makes the company about three times this, they estimated. This is the justification for the use of this equipment. They are now introducing word processors for the executives. Hence a man is handicapped if he has no typing skills. Sometimes people who have been with the corporation some years say - "That is clerical work. I am not doing that" - but such attitudes will be required to change in the future.

121. It may be some time before firms get people for junior executive positions leaving school who are able to operate keyboards. They do not need to type at high speed, 25 wpm. is regarded as more than adequate. The great drawback of many word processors is that they are not user-friendly enough. It has been claimed that this is because they are designed by data processing people rather than those who have experience of office routines and practices. The opinion at Greyhound is that the technology is there, but people have not yet caught up; the software is not yet designed to make word processors sufficiently friendly.

122. I was told that there is a community college in Pheonix that has a graduating course on which there are four subjects which have word processing content. Once people have the concepts it is not difficult to train them on the gear which Greyhound use. Within a short time they will be requiring people who apply for clerical positions to have had word processing experience before joining the company.

123. I was told that at Los Angeles, at the Greyhound bus depot, they are experimenting with a machine which issues tickets and which is micro-processor based. This is rather like a POST which is polled each night by computer. They are hoping that this would result in staff reductions in time. In this connection, after leaving Phoenix I went to the Greyhound bus depot at San Jose ordered a ticket for a somewhat complex journey of 350 miles with 3 changes and ending at San Francisco. It took 3 attempts and 15 minutes to issue the ticket, hindering other passengers who wanted tickets. The system certainly needs to be automated.

124. The Bay Area Rapid Transit system (BART) for commuter traffic into the centre of San Francisco and its suburbs has 34 stations, some are underground and others above ground level. An interesting point is that they use ticket dispensers which employ cards similar in appearance to a credit card. A magnetic strip runs the length of the card. Cards can be purchased at any station for any amount in cash or in notes at the choice of the traveller, up to a maximum of $20. The total cash inserted is printed on the card as it is issued. The card is then inserted at the barrier to gain access to the platform, rather like the method used at some London tube stations. It must also be inserted at a similar barrier to leave a BART station. The amount of the purchase price less the cost of the journey is printed on the card immediately below the first entry and the card returned. If the card shows insufficient funds to pay the fare, the ticket is then returned and the barrier remains shut. It then has to be taken to an 'Addfare' machine so that it can be 'topped up' by a further payment. Completely exhaustedtickets are retained automatically at the barrier. The BART system promises to return any card found without charge to its owner and people are encouraged to write their name and address on the card. Ticket dispensers, entry and exit barriers and Addfare machines are microprocessor based terminals with magnetic tape readers and a four digit printer.

125. ELECTRICITY SUPPLY

A paper to the Electric Energy Conference, January 1980, sponsored by the Institution of Engineers, Australia and originating from the British South East Electricity Board, describes a credit and load management system for an electricity supply company. The system measures the electricity supplied and maximum demand, calculates outstanding charges to date on an on-going basis, enables all customers to be charged at revised tarriff rates at the same date, enables meter readings to be taken remotely at will and detects loss of supply at the customer's premises. It monitors the supply for high and low voltage and earth leakage, and safeguards against tampering. In an emergency it enables load sharing to be effected on a controlled basis and thereby facilitates improved load management. These features could easily be extended to gas and water supply, details of which could be recorded separately from those of electricity. The system uses active terminals on the customers' premises and telephone lines to convey data and control signals. It is understood that a pilot scheme is already in operation in Guildford.

126. GAS SUPPLY

The South East Gas Board (SEGAS) has 6000 staff of which 4500 are in some form of management. They claim their business is still expanding at about 5% per annum, but the numbers of management and manual workers remain fairly constant. They have word processors linked into a communicating system but this is still at an early stage. It is intended eventually to reduce inter-office mail and use word processors instead.

In 1970, they said, they had one terminal for every 1500 employees, now they have one for every ten, and in five years time they estimate that it will be one for every six. A scheme is operating in some showrooms where terminals are used with VDUs for the receipt of cash. This is also intended to reduce dependence on the postal system.

They have identified a training need for staff who have access to VDUs. Office staff need a basic understanding of computing fundamentals, ie information processing. They need keyboard dexterity too. There will be more

keyboards around and more coloured displays on VDUs but the Querty keyboard is here to stay. In many situations the capability of typing with both hands is required but not necessarily at very high speed.

For management posts there is a need for a greater understanding of computing as a management tool.

127. They claim that there is evidence in the UK (more than in other countries), of a lack of ability to write letters well and to spell acceptably. There are problems too with interpersonal relationships. They maintain that the greatest potential for the applications of microprocessors is in the service industries, such as the gas industry, where large numbers of people are employed in offices. They estimate the average investment per person sitting in an office is £5000, whereas in a factory it is £20,000 (see paragraph 121). There is thus plenty of scope for the automation of offices. It is the opinion of senior staff at Seagas that in the next five years we shall see the advent of electronic mail within organisations like theirs. Word processing and data processing will be in common networks. They believe that computer links to their large suppliers will come next. A public service will very likely come about in ten years time. This must result in changes to the pricing structure of the Royal Mail. At the present time they have over 600 VDUs and terminals in their systems, running at 256,000 message pairs a day. They believe by 1984/5 they will have 1200 VDUs running 540,000 message pairs a day.

128. Seagas' staff believe that home billing through a Viewdata 'gateway' and catalogue selling by Prestel will come. However, they would like to have direct debit monthly payments, so that they would need to have annual meter readings only. If all meters were digitised and placed on the inside of an outside wall, they argue that the meter could be read by plugging into an outside socket without entering the customer's premises. They declare that, for them, automatic meter reading is still 10-15 years away (but see paragraph 125).

The Board are looking at data capture by radio and it is expected that portable terminals will be in use in two years time. It is intended to put VDUs in fitters' vans and to operate via a radio link to Segas' computers. In this way Stores information about spare parts could easily be obtained and servicing time much reduced.

129. School leavers, I was told, are weak on mathematics and English. The calculator has been the main cause of idleness, they contend, since calculations made this way tend not to be checked and orders of magnitude are not always appreciated. Letter and memo writing is poor. However, they said, they are more satisfied with their technician workforce than with school leavers. They had a disastrous year in 1980 with 16 year olds but quite good results with technicians. People are far less willing to put themselves out nowadays. They reject eight school leavers for every one they take on. People do not regard themselves as mobile now, and are not always prepared to move on for a job. There is a reluctance to take on apprenticeships by school leavers, even when they are offered them. Educational counselling does not always make it clear what sacrifices are needed to achieve better career prospects and long term rewards.

130. THE TELEVISION SERVICE

Teletext (Ceefax and Oracle) has now been in operation for about four years but its acceptance by the public has been handicapped by the cost of sets or adaptors. Generally the industry does not seem to have been very active in promoting this valuable innovation. (In retrospect it might have been better had they incorporated the system into all new sets sold. The larger sales would have paid off the development costs more quickly.) This system can handle up to 800 pages of text without the response time becoming unacceptably long. Of course, separate repertoires can be transmitted on each TV channel. This system is not user-interactive. However, it was hoped to move in this direction by the introduction of Telesoftware. This service, intended to be available from both BBC and ITA without charge in the 1980s would have meant that TV sets would have been able to use a wider range of video games, or be used as a calculator to deal with domestic accounts. The TV set could also have become a flexible home educational terminal (paragraph 13). However, in the autumn of last year the BBC announced their new Computer Literacy Project, a scheme planned to start in January 1982 and aimed at viewers in the home, in college, in school and in industry. The object of this scheme is to teach about computers and computing, including programming at many levels. A computer together with accessories and associated software tailored to the needs of the scheme will be offered for sale.

131. This effectively steals a march on the BBC/ITA Telesoftware plans. The Literacy Project will be built around a ten part TV series; it will include a book, a linked microcomputer system, a user guide, a range of applications programs and an associated course of programming in Basic provided by the National Extension College. At the time of writing it is obviously difficult to predict the impact of this project. However, the BBC claims that a microcomputer will be available from the autumn 1981 for approximately £230, offered in collaboration with Acorn Computers of Cambridge. The notes provided by the BBC show that there is to be a range of extras which can be purchased including disk drives and printer. The total cost could be up to about £2000 if all the items are purchased. If it is successful this project will undoubtedly enhance the impact of microelectronics in the UK on the general public, and it could be that some of the other estimates made in this report could then be of shorter time-scale.

132, TELEVISION RENTAL

Whilst the television rental companies are not public utilities they are included here because of their close connections with adjacent sections of this report. This is a major and growing industry, one company alone having one million colour TVs and 300,000 monochrome receivers for hire. They also hire out 40,000 video recorders. They employ a substantial maintenance workforce. Due to amalgamations in the industry this company now has 35 different TV chasses in their sets, and hence their maintenance has to account for this diversification.

They employ four technician grades. All of them are trained in video recorder servicing although at the present time there are not enough video recorders on hire to make this thoroughly worthwhile. 25% of their technicians are trained on Viewdata also. It is their belief that there is a lot of scope for industrial Viewdata systems (in addition to British Telecom) each using their own computer and operating over telephone lines. It is their opinion that Viewdata will not be part of the main domestic TV receiver, however; instead it will be a separate set which will be kept in the study or some such place. This company is putting Viewdata sets into travel agents' offices now that many airlines have pages on Prestel. They regard this as an investment, though they

have not yet received a great deal of return for their efforts. They are investing in the future, they say. Initial training of technicians in this company is carried out in FE colleges on a part-time day release basis whilst the student is still an apprentice. But following that, the company do their own training and retraining, due to the frequent changes taking place in the technology. They now have 13 people who are employed solely as trainers. The experience of this company is that they are satisfied with the results from FE colleges and they find that young people take to the new technology very easily. A few years ago they had 2500 technicians, now they have 2000. The drop is due to the higher reliability of modern equipment.

The problems they find with students are that many people have difficulty in reading well and in writing well; people's attitude to life is now poorer so that standards of performance have fallen; and people are not prepared to go anywhere for a job.

BRITISH TELECOM (BT)

133. The Telephone Service

At Area Office level terminals are in use for billing and payroll and are connected on-line to a BT computer. Meter reading is done photographically and the photographs of the meters at the exchanges are used for manual keying at each terminal. Touch typing is not a requirement but some keyboard skill is very important. There is a union agreement that staff may not use a VDU for more than 90 minutes per session (ie 3 hours per day) but this does not apply at the moment to stand-alone microprocessors as this has still to be negotiated. For this reason there are no word processors in the typing pool at the Area Office.

Billing work may involve a lot of contact with customers, and hence, new entrants must have the self-assurance to deal with them. In time, they pick up the job from older people but often without the application that older employees have. Microcomputers are being used for training at this level; programming is not a problem because only a minimal amount of development is done at the Area Office. This is still at a fairly experimental level with stand-alone micro-computers. At the present time there are four computer centres for the whole of

the country. It is BTs intention to replace this by billing by small local computers but it may be some years before the service is fully operational. This would be controlled by a standard program package. The training of new staff is done via a programmed learning package which comes in book form and takes three months to complete. In future it is likely to be done at a BT training centre in London. The idea is, however, still under consideration. The difficulty is keeping the programmed learning package up-to-date. Some new entrants from school are sent on Business Education Council (BEC) courses and some take computer appreciation, but not all of them. It is the BT view that this topic is essential. They feel that computer appreciation should be taught in school as well as in college.

At headquarters BT has a 40 terminal in-house communicating word processor and electronic mail system. This system uses a software package 'Scrapbook' and operates between Chairman and Directors of Regional Boards and some HQ Directors. This was the best example of executive terminals which I encountered in the public utility sector.

A number of payphones of new design and manufactured by Plessey Telecommunications have recently been installed in major cities. They operate with a push button key pad and have liquid crystal display for simple instructions. This shows the total amount of cash which has been inserted or how much credit is left during a call so that the user can 'top-up' for long distance calls. This payphone also provides change at the end of a call from the cash supplied at the start. There is also a payphone prepayment card called AUTELcard which has been introduced jointly with Emidata and Autelca, a Swiss payphone manufacturer. The card is inserted in a slot instead of coins. Its value is displayed on a digital read-out and the value automatically reduced unit by unit whilst the call is connected. The card is returned to the caller at the end of the call, its value having been reduced by the relevant amount.

134. Long Range Planning

BT has a unit whose particular concerns are the things that lie beyond those with which other parts of BT are at present concerned. It gives advice to management, mostly long term but not always so. They claim to be less interested in the fundamental developments in technology and more interested in

what can be done with the capabilities that are emerging. It seems that their role and the advice which they give will be affected by the government decision on the BT monopoly. This arises from a recent study of BT which advocated that in the home market there should be no restriction on the freedom to offer services to third parties contrary to Post Office policy over many years. The clear aim of the long range planning unit has been to use this policy to protect BT as a business.

They believe that something must be taught to students about the systems content of the machines they are operating. They also say that some change needs to be made in society but they are not precisely clear what is needed or how long it will take to achieve it. They believe that teacher training is where the essential solution lies. There are four points which they think important:

1. the world is moving to new ways of dealing with shopping and finance,

2. the extent to which students need to be exposed to new digital 'tools' such as VDUs and calculators needs to be examined,

3. the implications of their use must be identified (eg will the shorthand teacher survive?)

4. the role of subjects such as journalism and creative writing will need to be examined. Educationalists will need to carry out more research and development.

135. Viewdata and Teletext

TELETEXT is the generic term for systems such as CEEFAX and ORACLE which are available in non-interactive mode, transmitted simultaneously with television video signals. At the beginning of 1981 there were 400,000 sets capable of receiving such systems in the world of which half were in the UK. By the end of the year it is expected that this world total will have more than doubled (see paragraph 130).

VIEWDATA is the generic term for such systems as PRESTEL, operated by BT at a number of regional centres, using telephone lines and using either TV receivers or purpose-built monitors as VDUs, interactively. The number of pages available on Prestel is 180,000 at the present time. This is a British invention; its take up seems to be greater in Europe than in the USA. There are, however, a number of systems which are, or are about to become, public, although the British one was the first. The West German system is now operating; in Canada, Teleglobe (their equivalent of BT) is introducing their system TELIDON. This system will have up to 100,000 pages. Terminals and software are being provided by Informat of Toronto. The German public VIEWDATA system has been particularly keen to introduce 'gateways' to private computers. By the beginning of 1981 there were nine external computers connected to a system which operates from Berlin and Dusseldorf.

Semiconductor manufacturers lately appear to have responded better by designing new adapters for these systems, with Mullard perhaps leading this field.

136. The implications of PRESTEL and similar systems across the world are considerable for education. The British system is regarded by BT as a market place provider and the only control which they exercise is in terms of morality and legality. A wide spectrum of organisations have paid for the opportunity of availing themselves of that facility. For example, PRESTEL gives access to FINTEL which is controlled by a group including the Financial Times, and contains up-to-date news on companies' recent developments, basic company statistics, corporate information and inter-company comparisons provided by the Investors Chronicle. There is a trade directory provided by INSPEC, the Institution of Electrical Engineers' company, and a guide to active electronic components by IPC. A wide range of statistics is available such as the retail price index, inflation rates for the UK and abroad, monthly averages of exchange rates of sterling and other currencies and latest closing prices.

137. PRESTEL provides information appropriate to many of the subject areas taught in FE colleges. For example, basic data on over 100 foreign countries and living and travel costs in EEC countries. Are supplied by The Economist. There are tax guides; information on importing and investment, information about

books for businessmen. Other information is available to closed user groups. This means that private, confidential or especially valuable information can be obtained on the PRESTEL computers (they operate in pairs to guarantee a continuous service) but with restricted access to those who need to know and can pay for the privilege. Access to this and also to home banking is provided by a system of passwords and identification numbers. It has been suggested that the cost of maintaining a telephone directory enquiry service, general directories and 'Yellow pages' is so large that it will be abandoned within the next ten years and replaced from information from a PRESTEL-type service. Already the French have attempted to do this in a pilot experiment in which they are providing terminals for all subscribers in the experiment in a limited district. The price of these, were they to be mass produced, would be about £30 at 1980 prices. The experiment is understood to have met some difficulties. Nevertheless, it does introduce a terminal to subscribers which could then be used more generally for VIEWDATA.

138. BT Technical Training College, Stone

This college has a staff of 154 lecturers and 130 instructors who look after the practical side of courses. Altogether including support staff, there are 700 staff. It is largely residential with 864 bedrooms. BT take on apprentices aged 16-17 years against a set requirement for the technical officer grade, the highest workman grade. Training is undertaken for them and for some of the more senior supervisor grades, using training models of equipment. Although this college is the central training establishment there are 11 other BT training centres. They are convinced that computer-based training is now very important. They are using the 380Z microcomputer (Research Machines of Oxford) as a standard. BT has a total workforce of 240,000 people of which 30,000 are managers. There are three functions which this college fulfils:

i. the training of people in the way outlined,

ii. the creation of an awareness in the staff at Stone;

and iii. the development of their own technicians in the new technology.

Their philosophy of teaching the new electronics is of interest. To motivate people they actively try to create loyalty to a system, such as a computer,

rather than to the organisation, since at the moment that is supported by obsolescent technology.

139. An apprentice goes first by day release at an FE college where he takes a TEC course and afterwards to the college at Stone to take specialised courses. BT say they have their doubts abut the role of technicians in future. "What" they ask, "will be the role of the technician when you have a system to maintain, which itself prints out a list of probabilities of failure for given symptoms?" Any technicians they need will have a greater depth of understanding. Also they will need a lot of people to do the 'housework' maybe in 5-10 years time. However, they have a lot of maintenance of older equipment still to be carried out. They claim they are still five years away from a system where a technician pulls out a component and inserts another one at the instruction of a computer. They are very anxious that people should get away from a 'Luddite' approach to new technology. It is their aim, they say, to create a pride and a "We have the highest technology" attitude.

The college at Stone has been growing at 5% per annum since 1947 and at the present time the accommodation is fully used. For that reason BT are looking closely at distance learning. They have access to the 'Plato' system at Barnet which can be programmed in author language rather than in higher level languages. This system could be used to control a course. It shows which books are to be read and the course work to be carried out. It asks questions as the course proceeds, referring to the VDU beside the student. They have two Plato terminals at this college and intend to get eight more. However, it could only fulfil the functions described, with terminals in students' normal workplaces throughout the country.

140. The point was made that the education system does not set out to identify what gives a person satisfaction. The function of education is to give knowledge and information and then test it. It does, not, and probably cannot, put values on creativity. But this is more important than passively watching TV. They are concerned that developments in society have led people to be more eager to exercise their rights than their responsibilities. They recognise that modern equipment is more reliable and hence technician skills are needed less. This could lead to frustration in society with all that implies.

PART SEVEN - PERSPECTIVES FROM TRADE UNIONS AND PROFESSIONAL ASSOCIATIONS

141. PROFESSIONAL AND COMMERCIAL TRADE UNIONS IN THE UK

The national and educational press has drawn attention to new ventures supported by government departments to fund microelectronics innovations against a background of disquiet from various trade unions and professional associations. They are concerned with the need for caution in the face of diminishing job opportunities as typified by the predictions in 'Collapse of work'. /2/ For instance, it is said that one of the major functions of the MAP scheme is the massive expansion of places on short courses in microelectronics applications. The number has increased from about 2500 to 36,000 in about 150 existing educational organisations in the public and private sector. MAP support has been offered to the TUC for a national shopfloor training programme for more than 60,000 workers and union officials. Open University courses in microelectronics applications have also been offered. But at the same time it is being said elsewhere that microprocessor development is potentially the greatest threat to employment since the Wall Street crash. Pronouncements of union leaders have stimulated research efforts on the part of others, including trade unionists, so that less alarming and perhaps less exciting views later are beginning to emerge. Of course, it goes without saying that these views attract far less attention.

142. Clearly, commerical and industrial processes are being changed by the new technology. More than that, new ways of making things are coming in to such an extent that some products are disappearing and entirely new products (eg hand calculators and PRESTEL adapters) are entering the maket place. Perhaps one of the largest problems confronting British society at the moment is how to transfer labour from the manufacturing industries where jobs are shrinking, into the new information technology-based industries which need to be subsidised by the Government until they become solidly based. It is at this point that one of the proposed roles of education becomes clearer, for education and government subsidised research and development could provide an information base from which new technologies would emerge to maintain our position in the world market place.

143. A representative of the Civil and Public Service Association (CPSA) pointed out that the recent history of trade unions has not always helped, even the union themselves. His union were against mainframe computers when they first came in, but now they realise that in order to maintain their position they must go along with computers. Hence their policy now is to accept new technology. They are prepared to negotiate since in the past they have lost workers to other unions in this way. Such issues as programming for the new BT systems 'Herald' and 'Monarch' have now become inter-union issues. He saw that in the past his union has been slow in changing their policy and in recognising a new situation, due sometimes to the officers' own personal lack of knowledge.

144. At the 1981 conference of the 450,000 strong Union of Shop, Distributive and Allied Workers one delegate is reported as saying, "Job satisfaction is a thing of the past. We work in smart conditions, but battery hens are also in smart conditions. It is almost as self-destroying as being unemployed. We don't have a skill and we have no identity." This referred to the staff who are operating new technology and they single out for criticism the visual display unit, their input to a computer system. Operating a VDU it was maintained, causes headaches, eyestrain, tiredness and boredom, and nobody was ready to help them. Naturally the employer did not agree. Some companies have obtained medical advice to support the contention that properly used there is no hazard. Nevertheless unions have negotiated with employers for a limited time, typically 90 minutes per session, with VDUs. At one company it was suggested that when the 90 minutes were up they went to the rest room to recover - and watched TV!

145. The Technical, Administrative and Supervisory Section of the Amalgamated Union of Engineering Workers (AUEW/TASS) claims to be Britain's largest engineering staff union. It has over 200,000 members and 40 full-time officials. The centre spread of TASS News and Journal for May 1981 was devoted to an appraisal of the new technology. They claim that in the fields of computing, telecommunications, intruments, consumer goods, components and capital goods the number employed were:-

1970	516,000
1975	500,000
1980	454,000

They point out that in Japan, 70% of 15-19 year olds are in fulltime education whereas in Britain this is only 45%. (The figures quoted in MSc's New Training Initiative, May 1981, for 1977, are 32,000 in school and 10,000 in further education.)

Education, training and retraining are the raw materials of the technological advance, they claim. They are naturally critical of government cuts in education and training. They claim that the results of the Finniston enquiry have been largely ignored, and even though the Finniston remit included technician training, Finniston declined to comment on it. It is their view that the problem is not only in secondary, tertiary and adult education. They claim (with the Jesuits?) that the quality of technologists in partly determined before they are seven.

146. The Association of Professional, Executive, Clerical and Computer Staff (APEX) produced a working party report in March 1980 'Automation and the Office Worker'. APEX says that new technology has brought with it substantial changes in industry, such as the catastrophic effect of electronic digital watch manufacture on the Swiss watch industry. Their concern in their report is to look at the impact of electronic technology on office workers. They say that the function of offices revolves round the collection, handling and provision of information. They claim that in 1978 at least one third of all employees in the UK were engaged to a major degree in the information sector.

Amongst their conclusions is a recommendation that unions should seek technology agreements with employers. They do not say, however, that some Industrial Training Board officers have foundthat innovation is more likely to be successful where the employer's freedom of action has not been limited in this way. APEX argue that when unemployment is likely, technology agreements can guarantee, at company or site level, that employees will benefit from automation or at the very least not lose by it. They see that this will necessitate bargaining machinery at group and company level to handle a whole range of issues surrounding technological innovation. They do admit, however, that some of problems arise from inter-union disputes. Technological change challenges established occupational and skill categories which may also be the basis for revision of inter-union demarcation lines. They look forward to the intended emergence of unified trade union strategies. In their report a number of

recommendations and parallels are drawn with the Health and Safety at Work Act, but in this instance they do not recommend the election of separate technology stewards analogous to health and safety representatives. They are anxious that trade union officials themselves, as well as negotiating committees, should obtain advice on the technical aspects of new systems before they are able satisfactorily to gauge the precise implications for the employees they represent. They look to colleges as places from which this expertise could be obtained.

Whilst on the one hand APEX welcomes the increased output, productivity and increased living standards which microelectronic technology would bring, on the other hand it recognises that if the industry is to compete successfully in world markets it must keep pace with technological innovations occurring in other countries. They have recognised that training and retraining schemes need to be planned in advance of the introduction of new systems, and tailored to the specific needs of groups of workers according to their backgrounds and abilities. They recognise the need of education, aimed first at the union officials themselves, and suggest two day seminars and intensive one week residential courses for negotiators but with a view to developing greater expertise amongst the membership as a whole.

147. Tim Webb of ASTMS writing in the Computer Bulletin in June 1979 not only criticises politicians for laissez-faire policies but lists specific demands. Generally these imply improved conditions of service, such as a shorter working week and the establishment of a five week minimum annual holiday, excluding public holidays, and voluntary sabbatical leave. This is based on the assumption that the new technology would involve an overall loss of jobs. However, as the recession has deepened since then, some of these aims, necessary as they might be to spread work more thinly and so more fairly throughout society, have been seen to recede visibly.

148. The Trade Union Congress itself has been very concerned about many of the developments discussed so far. The TUCs SE Region Council reported in September 1980 on 'Office Employment in the 1980's.' This sees as central to the trade unions' approach, the need to build up collective bargaining strength and expertise at the workplace, to some extent echoing the conclusions of APEX.

They put more emphasis on trade union representatives pressing their demands effectively rather than on the disasterous effects of failing to change. Our competitors in Europe and across the world will not fail to take advantage of opportunities as President Reagan's statement in May 1981 that 'money will be available to ensure that the USA does not lag behind Japan' shows. So then, we must keep up too. Education has its part to play to achieve this.

The TUC does see, in the longer term, that trade unions will need to press for broad economic and social changes to ensure that the new technology benefits the whole of society. But the nature of these changes are only hinted at.

149. A joint TUC/CBI statement 'Technological change' was issued in 1980. In this document it appears that both parties have recognised the need for technological change and have accepted that this is most likely to be achieved on the basis of their joint approach. They recognise the responsibilities which could face them and agree to set out the key elements of practices most condusive to the successful pursuit of major technological adaptation. Understandably, one of the key issues which are discussed in this statement is that of security of employment. It is perhaps significant that under this heading is the comment that wherever possible, company efforts should also be made to assist employees to find employment outside the company. This could be taken to mean that it is inevitable that some companies will find difficulty in surviving without reducing their workforce. It is encouraging that under the heading of 'Skills training and retraining' they draw attention to those employees who might be identified as being affected by the new technology in an adverse way and recommend that they should be given the opportunity for retraining on the principle of maintained earnings. If successfully retrained, they should be given priority in applying for new jobs wherever possible. However, in both the TUC/CBI and TUC documents little detail is given on the educational and curricular changes needed to accompany the sociological ones.

150. THE TEACHING UNIONS

The Association of University Teachers (AUT) in April 1979 replied to a letter from the Department of Education and Science (DES) headed 'Microelectronics and

Education' to the effect that the emphasis which the DES was putting on the applications of the new technology and its practical consequences rather than on the scientific base of the new technology was probably right. However, they saw that in the longer term this aspect of the technological science might be picked up in another programme. The MEP scheme announced in November 1980 goes some way to meeting this.

151. The Association of Principals of Colleges (APC) working party on microelectronics and its effect on the curriculum reported in June 1980. They argued positively that microelectronics will introduce entirely new skills and new job functions or at least so change the old skills and jobs that to all intents and purposes they will be regarded as new. They commented that the spectrum of ability in schools is to a large extent mirrored in further and higher education. This is particularly true of those parts of the country which not only offer university, polytechnic and conventional technical college facilities but also provide a programme of remedial education, especially for low achievers at school, or for those who for a variety of reasons are already at a disadvantage in seeking employment. They then went on to make recommendations for these groups. Their report went into detail on various specialisms which are offered in colleges and the ways in which they might be affected by innovations in microelectronics. One of these is for Office Skills and Business Studies. They said that this is an area where the use of limited instruction sets and keyboard techniques need to be quickly appreciated.

They also drew attention to the ways in which credit cards and cashcards are becoming more widely used, particularly in departmental stores. From this they inferred that stores will be needing staff of higher ability at cash tills. Although more will be expected of salespeople, they suspected that fewer of them will be needed.

152. In an article in the February 1980 Journal of the National Association of Teachers in Further and Higher Education (NATFHE) it was suggested that fundamental changes are needed if Britain is to enjoy the opportunities

presented by the emergence of 'the chip'. Time may be running out. Amongst the curricula implications discussed is an admission that fewer children and young people will in future need to be prepared for a working life in the manufacturing industry. However, the few that will be, will undoubtedly need higher order skills than at present. They argue that the school curriculum must take greater cogniscance of the chip, whilst in post-school education, course structures need to become more open-ended so that re-entry and retraining with continually updated programmes can become a possibility.

NATFHE produced a circular in May 1981 'Educational implications of the new technology'. After outlining the economic and employment effects, the document then turns to the educational needs. It argued that all new entrants to the workforce will need to achieve a basic awareness and understanding of the new technology, and for many this will include some operational skills. They recognised also that only a relatively small number in the teaching profession have acquired these skills themselves. The document is encouraging in that it urged teachers and students to use the new technology in learning situations, confident that microprocessors do not represent a threat to a teacher's professional standing or to his livelihood. NATFHE should be congratulated on this statement. Despite the point already made that the majority of teachers do not have these skills, the paper went on to urge that institutions should assist firms to identify their own training needs and to co-operate in devising courses to meet them. They visualise teachers carrying out studies of firms' needs and conducting courses on firms' premises. This may be a medium term aim, but in the short term it seems to me that whilst one or other of these arguments could be substantiated it might be dangerous to rely on both of them.

NATFHE clearly recognised that clerical and unskilled manual workers are particularly likely to experience the adverse effects of the new technology. They also commented that many workers in these groups are women. They called for special efforts to be made to ensure that positive educational manpower planning policies are developed, creating new jobs for those displaced by the introduction of new technology. In reality the change-over to the information-based society may not be as smooth as this. Whilst the ways in which job opportunities will be lost due to the new technology are fairly clear, the ways in which new jobs are to be created are far less obvious.

The NATFHE document also drew attention to some deficiencies in the teacher education process. It recognises that the MEP strategy of providing a range of courses through from basic awareness to advanced levels identifies many of the needs that exist. They argue that it is a lack of resources that is holding things back and they thought it unlikely that LEAs will be able to make any significant financial contribution in this connection. The Association urged the government to make funds available through appropriate mechanisms so that the necessary development work can get under way in colleges of education.

153. TRADE UNIONS IN THE USA

In the USA it seems that job enhancement is a major factor in negotiations between employers and trade unions. One argument raised was that people who sit all day long at a typewriter, particularly if they are handling statistics, are much happier when they are able to use a word processor, which is claimed to give much greater job satisfaction. (see paragraph 144 for the opposite argument) Hence the conclusion that this kind of enhancement leads not only to greater productivity but also to more pleasant working conditions.

At some major electronics companies in California I was told that there are no unions and the companies are openly paternalistic. For example, they offer stock purchase options (regular savings towards purchase of stock in the employing company, and for some more senior people, stock option (the right to purchase stock at some future date at an earlier more favourable price)), available without paying brokerage. There is also a participative management programme which is a type of bonus scheme in which a group of people set their own goals in conjunction with the employer and obtain a bonus on reaching or exceeding them. Health and dental care are often free and some insurance paid for by the company. One manager said, "Unions cannot provide anything our workers already get." - except perhaps salary rises and the right to strike?

One semiconductor manufacturer has a Credit Union subsidiary for the benefit of workers. This provides loans and mortgages and gives advice on investments. With all the benefits, it might be thought that it is difficult for a worker who wishes to leave a firm of this sort to disentangle himself from the company's financial threads through his life.

154. TRADE UNIONS IN EUROPE

In the EEC there are approximately 150 million workers and in the UK there are 21 million. A report from the European Trade Union Institute in Brussels draws attention to the varying impact produced on different sectors of industry by the new technology. For example, it quotes manufacturing, transport, communications and finance as being highly affected, whilst agriculture, catering, mining, the utilities and construction are much less affected. This report bears out much but not all of this. It would seem, for example, that the utilities are likely to be more affected, particularly the clerical and administrative side of them. The report goes on to say that given the importance of trade to the Western European countries, it is clear that countries which are slower to innovate may well experience higher labour displacement and a declining share of trade due to reduced competitiveness. This does not seem to be the view of some of those speaking for the trade unions in the UK and whose picture of life is understandably coloured by the short term reaction of their own 'electorate'.

The report goes on to say that one tendency is for the introduction of microelectronics to reduce employment significantly in maintenance, repair work, assembly and tool setting. This represents a reduction in skilled manual employment. The proportion of semi-skilled jobs in Europe has risen in the immediate past from 15 to 35% and of highly qualified technical jobs from 2 to 30%. Nevertheless, in one company where a move to microprocessor-based products has taken place, quoted in the report as a typical example, this has resulted in a fall in the proportion of jobs requiring training from 82 to 35%.

However, training and education are not the key issues for the trade unions, who are more concerned about the way technological change will affect existing patterns of work organisation, levels of employment and conditions of work.

155. A report from the Battelle Institute in Frankfurt comments that their research results make it clear that the education system is of central importance for the development, application and control of the consequences of the new technology and that it must adjust appropriately to the changed requirements. They believe that vocational training and general education must be drawn closer together and indeed this sort of view is the natural conclusion from the comments made by some of the companies reported in the earlier parts of this report.

The Battelle Institute report describes the required type of education as the concept of social science/technology orientated education. By this one presumes that they mean that there should be at least an acquisition of the basic knowledge of the new technology together with appropriate life skills. They do not believe that there are any dramatic or surprising changes in vocational training to come out of this new technology, but here again, they contend that changes should take place in the training of teachers, since the knowledge of technological applications which many teachers have even lags behind that of some of the people they are attempting to train.

PART EIGHT - PERSPECTIVES FROM THE EDUCATION SECTOR AND THE EXAMINING BODIES

156. GENERAL INTRODUCTION

Over the past few years a number of articles have appeared in the technical press under general titles, such as 'Microelectronics and Education', which have put forward ideas which although perhaps directed to other sectors of education, also impinge on further education. An article with this title by David Bothwell in 'Computer Education' describes three aspects of the school curriculum which he feels will be helpful main headings for discussion. These are:-

i. education about computers;
ii. education with computers;
and iii. the impact of computers on the whole curriculum.

He makes the point that there is no suggestion of setting aside the secondary curriculum in favour of something quite different. What he does propose, however, is that a new dimension needs to be added if discussions about the curriculum are to have any worthwhile significance. He also states that we should be considering three specific kinds of skill:-

i. life skills;
ii. work skills;
and iii. learning skills.

All three of these, he maintains, have a vital part to play, not in isolation but integrated into the curriculum.

157. This article can be compared with the April 1980 report, 'Education and Training in Microprocessor Technology' produced by a working party of the Electrical and Electronic Manufacturers Training and Education Board (EEMTEB). Clearly if Bothwell's paper is considered as giving a general setting for this work, the EEMTEB paper must be considered as specific and aimed at preparation for technologists and technicians in electrical and electronic engineering. Amongst the EEMTEB recommendations are:-

i. to encourage LEAs, school governors and head teachers to embrace and encourage microelectronic technology through visits, lectures and demonstrations at industrial plants;

ii. to provide industrial experience as training for teachers;

iii. to produce advice and practical assistance in the field of teacher training;

and iv. to make use of PRESTEL and TELETEXT for educational purposes.

They also identify areas where there appears to be an unsatisfied need for higher level training. These include:-

i. high level languages;

ii. real time system design and programming;

iii. identification, use and operation of microprocessor development systems;

iv. advanced technology programmes (for example, the specification, design and use of tailored processors and specific aspects of paratronics, (including magnetic bubble memories, charge coupled devices and surface acoustic wave structures);

and v. the project management of software-based systems.

158. In 1980 the report by the Central Policy and Review Staff (Think-Tank) 'Education, Training and Industrial Performance' recommended that the policy towards the overlap between schools and FE colleges for the 16-19 age group should take into account the greater responsiveness of FE colleges to industry, the scope for rationalisation of small sixth form courses, the need to remove anomalies between teachers' and FE lecturers' pay and the advantage of a break between school and say, sixth form colleges, as well as the need for an evolutionary approach. Their recommendations included for schools a core of English, mathematics and science, and the development by pupils of skills in dealing with people. All this would seem to bear out the declared needs of employers for literacy, numeracy and better inter-personal skills.

159. 'The Silicon Factor - Living with the Microprocessor' a booklet published by the National Extension College in conjunction with a BBC series in 1979 has one chapter devoted to 'Microelectronics and the Education and Training System'. A part of this is of special interest because it also points to an important function which our education fulfils, in training us socially in manners and habits. This 'hidden curriculum' is of great importance and if we neglect it or continue to do so, then we are bound to have more complaints from industrialists and people in commerce that the inter-personal skills of young people are insufficient.

160. In July 1980 the Institution of Electronic and Radio Engineers' one day conference on 'Retraining in the Electronics Industry for the Microprocessor Age' drew attention to one area which, so far, has been neglected in this report. This is the provision of microprocessor training courses by commercial organisations. Passing mention was made earlier to work done by some semiconductor manufacturers both in the UK and in the USA. One company operating here, Bleasdale Computer Systems Ltd, was granted £213,000 from DoI to develop and equip a range of training courses on the applications of microprocessors to industrial systems.

161. It might well be thought strange that no organisation at any level in the state sector of education (including the universities) was able to carry this out. Bleasdale's courses vary in price and length up to almost £500 for a 2-weeks course. In their paper, J Walker of Bleasdale drew attention to a new profession, that of the software engineer (familiar ground to readers of this report). He claimed that this is a new profession combining the expertise of both electronic engineer and programmer; equally at home with sensors or structured programs, PROMs or Pascal, and RAMs or relocatable assemblers. The extent to which this comapny or any other in the private sector has succeeded (or even attempted) in dealing with the problems just mentioned, has not been investigated in this project.

'Industrial Retraining Programmes for Technicians and Craftsmen' is the title of a paper by D F Bond given to the same conference. He infers that curricular additions might be as follows:-

The description of new products, new electronic components, new assembly and production, new product market profiles (including volumes and anticipated cost structure).

Whilst these can be inferred from the paper, the requirements are always put in 'end-product' terms, rather than as detailed curricula input.

162. One of the ways in which curricula changes have been suggested in technical articles is by describing the experience of teachers. In one such, in 'Practical Computing' September 1980, headed "Micros should supplement textbooks - not replace them" Rex Tingey looks at ways in which games can be played using a microcomputer to motivate young people so that they set about acquiring useful information. One of the examples given is in geography. The game asks for guesses at the name of a river or capital city and the computer commences letter by letter to spell out the name which the player is being asked to give. The game proceeds until the player completes the name. There are other programs on a somewhat similar theme using the symbols for a chemical element and its atomic number.

163. In the NATFHE Journal, October 1980, Tony Shaw suggests says of keeping the educational service abreast of developments in microtechnology. He suggests that most colleagues should be capable of offering something in the form of exhibitions, courses and a co-ordinating function. A proposal for undertaking this could form the basis for an approach to the LEA for resources. He makes the point that an explanation of the terminology of microelectronics could be one place to start. He goes on to suggest short courses on such topics as programming, introduction to computing, microelectronic hardware and applications, and electronic components and circuits. In addition he sees that there is a clear role for colleges offering link courses in this technology. Some of these could be TEC units or computer studies (a few colleges are doing this already), basic electronic skills, foundation courses, specialist lectures, etc. In May 1981 the same Journal had a two-page spread on Microelectronics, the major thrust of which is government handling of finance for micro-electronics, a topic outside the boundaries of this report. Nevertheless it claims that relatively low priority has been given to initial teacher training in the MEP scheme. This seems to be rather short-sighted because without this

the impact of MEP will be less than it might otherwise be and provision for the future is an important strand in educational planning.

164. SECONDARY EDUCATION

It is not the intention of this report to summarise the impact of micro-electronics on schools. However, attention can be drawn to one or two examples of work going on in or for schools which could easily be mirrored in further education. For example, a number of universities have offered courses in microelectronics for beginners, including one intended primarily for sixth form physics teachers. These courses are typically two or three days in length and are offered at a time when the university has accommodation available. The fees are often relatively low compared with commercial courses. To be successful such courses must involve a substantial portion of hands-on time.

165. Report 18 of the 'Schools Technology Forum' for June 1979 draws attention to what it believes are important ground rules. These are:-

i. pupils must acquire hands-on experience and become familiar with technological components;
ii. pupils must develop a knowledge of the way in which such devices are used and know something of the design of systems;
iii. pupils should develop a capability to appreciate how technological problems can be solved;
iv. pupils should develop the capability to use their science and mathematics in a design for a working engineering system;
v. pupils should experience the excitement of successfully overcoming all the hurdles on the way to creating a device which meets a specific need.

It seems that these five items, whilst not exactly curriculum matters, suggest topics under which curricular changes might very well be brought about.

166. A paper by the Scottish Education Department for a meeting on the Micro-electronics in Education programme, June 1980, referred to a survey of microcomputer systems in educational establishments in Scotland which sought to establish the extent of regional and school- or college-based initiatives. An

interesting point was that one of the results of this survey was a list of the types of computer programs available at that time in Scottish schools. Packages, defined as programs available on tape or disk, for use by pupils or staff had been produced by most of the users. 967 of them, all using BASIC, were identified and their distribution by subject area was as follows:

games	25%	general	18%
mathematics	20%	science	12%
geography	2%	business studies and administration	19%
technical engineering	4%		

The total number and the wide spread of interest in these programs are heartening examples of the way good motivation leads to developments such as these.

167. 'CAL at St Patricks' by Joe Telford, published in 'Computer Age' September 1980, describes the way in which computer assisted learning (CAL) can be used in the school situation. His conclusions are somewhat similar to those of Rex Tingey (paragraph 162) but interestingly adds that he has identified eight separate types of computer program. These are:

practical/direct testing programs;		learning via game-playing;
reward after task programs;		demonstration/simulation;
information retrieval;		programs to teach computing;
work sheet programs;	and	involvement of extra peripherals.

This interesting paper makes the case for game-playing as a source of motivation in both primary and secondary education. Whilst this is only one of his types of program, nevertheless he concludes that there are a number of useful ground rules which apply to programs for schools and which are quite general.

These are:-

i. Instructions must be kept to a minimum and must explain how to operate the program.

ii. Instructions, for special key presses must be included in the section where they are expected.

iii. Questions must be to the point and if possible answered in the same line as they are posed.

iv. One should encourage the pupils after each question by using his or her name and simply explaining mistakes.

v. If possible have power switches, mains leads and reset keys well out of reach.

vi. Graphics should be used wherever they are available because they often mean more than words to pupils.

vii. Sound is useful to add realism (space invaders!). Also it focusses the attention of the pupils, but overdone it causes loss of interest.

viii. Demonstrations should be instructive with user operations kept as simple as possible.

These rules have been included here in full because they make it quite clear what engineers and others mean when they say a programmed microcomputer must be 'user-friendly'. Very many of these rules will commend themselves in the use of programs in further education.

168. HIGHER EDUCATION

There has been a healthy co-operation between polytechnics and colleges of further education and to a lesser extent between universities and colleges of FE. Both the universities and the polytechnics have had the funds which had they so chosen (and many did) could have been used to introduce a wide range of students to microcomputing. In a number of polytechnics I was told that every electrical student has a compulsory module using microprocessing. In one of them it was predicted that in electrical engineering, up to 25% of the course syllabus will be allied to microcomputing within the next five years.

169. One Scottish university uses Commodore Pet microcomputers and has a 20 hour course (10 - 2-hour sessions) of competence in BASIC. The interesting and perhaps disappointing comment was that the majority of those on the course are

mathematicians and engineers who need computing as a problem-solving tool in further study. One would have wished for a greater spectrum of interest from undergraduates in other disciplines. An interesting financial point comes out of the work there. On a pound-to-pound basis it proved to be cheaper to buy the Pets than to buy VDU terminals and connect them to a mainframe which already existed. It is worth commenting that a failure on any one microprocessor does not affect the others. Hence the reliability of the system was higher.

170. The variety of the courses for teachers in secondary schools which have been mounted by universities and similar establishments (see also 166) seems to imply that there is no ground for complacency, but nevertheless the active work going on will be invaluable in the years to come. The situation with word processing is not quite so good. One often hears that agreements with unions have still to be made, and until they are, the introduction of word processing is being held up. The impact which higher education has made on the schools has already in fact helped the universities themselves. Now young people who are applying for a university place, have been playing around with some form of microcomputer at school, sometimes because a parent-teacher group has put up the money for it (or soon perhaps due to government finance). This helps the university or polytechnic too, in their selection of school leavers as well as giving confidence to introduce microprocessors early in their degree course.

Unfortunately some universities are interpreting cut-backs in finance as applying uniformly across the university. Such a policy avoids the Academic Court having to make difficult decisions. In one case I was told that the university finances had already been affected and for the next three years it was likely to have a total cut-back of 11% of their budget. Following a policy of no redundancies, there had to be cuts right across the board, so microprocessor involvement must takes it share with the rest.

171. The effect of the American initiative recently is expected to increase dramatically the number of places for first degree engineers and scientists, and for masters and doctorate programmes. At one Scottish university I was told that there were 850 applicants for their electronic engineering degree last year to fill 62 places. This year the number of applicants who are home-based students is up by 15% compared with the same time last year, after the

university had, in fact, raised their requirement level. This year the limit is 60 places. It would seem that some encouragement is needed or academic liberty will be stood on its head in the name of equality.

172. At a university known nationwide for its high technology, I was told that the microprocessor was important in terms of employment since it removes the barrier of mathematics in terms of the training of engineers and scientists, so that we have a diminution of the skills required. There is I believe, some over-simplification as the following example, put to me, will show.

"Once we had to go into detail about what a logarithm is. It is still a necessity to understand that, but it is no longer necessary to teach logarithm tables or how to handle them. This gives more time to teach other things which are more worthwhile. Mathematics has, understandably, had an image of drudgery in the past, and now much of this has been swept away. The image of computing is one of high technology and having sophisticated programs available for demonstrations, many people become interested in engineering and computing as worthwhile subjects for study.

Again with office studies, comparing conventional office routines with future practice, we see that we no longer need to employ people for filing and copy typing. We use them instead to operate a machine for collating data. One is releasing time to do new jobs. Word processing takes away the drudgery of retyping. It has often been said that the skills are changing - not necessarily increasing."

173. The country is short of engineers to the extent of 30,000 people. The total output from universities is 3000 engineers and mathematicians per annum, so the shortage is likely to be an ongoing one unless we retrain or increase the size of the throughput. Retraining is in this area likely to be most successful with people under 40 years of age, but very little evidence of this was seen. As more people become involved in computers, I was told, software writing will tend to be of the menu type so that it will be less common to have to use a Qwerty keyboard. (I do not share this view.) The university offered courses designed to provide sound training in electronics for graduate level engineers and scientists in other disciplines. It would seem that some such scheme as

this could be made available for the retraining of teachers in primary and secondary education, so that they can influence people towards the new technology. But there is no point in influencing them unless the number of places at university is increased in those disciplines.

174. FURTHER EDUCATION

As part of this project a number of visits were paid to colleges for further and higher education. In this way it was hoped to sample work being done and see the equipment which was available. A number of interesting experiences came to light. In one college a severely handicapped student with problems of manual co-ordination was working at a microcomputer, using it as a word-processor and with considerable difficulty he composed and corrected a page of text. When the student had finished for the day, the lecturer obtained his text from a printer. It is understood that an approach has been made to an examining body for approval of this technique with an examination script. This seems to me a particularly commendable though somewhat expensive way of going about things. At another college there was 'An introduction to computer studies' for partially hearing students. This was augmented by work in keyboard skills in the commerce department. In the main computing course however, students could proceed at their own pace using specially prepared worksheets and prestored teaching programs until they were capable of writing simple programs themselves. They undertook projects which included such items as payroll simulation and one or two learning games. In many of the colleges visited, microcomputing was being tackled in three different ways:-

i. electrical engineering departments were using evaluation kits and were working in machine-code and assembly language;

ii. courses were running in BASIC and simple programs were being devised;

and iii. a number of colleges were already using microcomputing for college records.

175. One college had programs for college examination room loading, for ordering and invoicing. Another had a package for TEC level I mathematics, and several colleges had student records on microcomputers. In one case there was a

terminal at the Head of Department's desk to deal with enquiries from employers. Very few colleges had word-processors in use and it seems to me that this is one area where we should ourselves be practicing what we preach.

176. The point was made in a number of colleges that the entrepreneurial activity of a college is related to the local industry which it serves, or as one Head of Department put it, "A college rests on its local economy". If the local employers are active in keeping up with modern technology, then so must be the college. On the other hand the college can have a role in educating local employers in the implications of microelectronics. Some colleges are doing this by means of short courses for those in industry, and in one case information was being passed on to schools and others who might be interested through a conference for head teachers from local schools.

177. In a number of colleges, the staff of the college itself were seeking retraining from their colleagues and gaining hands-on experience on a basic informal basis. Some colleges have found that it has proved useful to carry out some market research on the main areas in local industry where microcomputers might be used but so far have not been. Another college said that they had made the study of microelectronics a priority area for its own staff, and study-leave, small though it was, was devoted to this topic. It was stressed in a number of colleges that if they did not respond quickly enough, then unemployment resulting from a lack of ability to exploit the technology would occur not only in the companies around them but also in their college as well. At one college a Principal was anxious to stress that there was a tendency for the electrical engineering department to mount 'straight' courses on microcomputing, whereas the local need was for new automated office procedures which really required work shared across departmental boundaries.

It should perhaps be mentioned in passing that one college had invested in two 'space invader' machines which were in use in the students' common room. They were bringing in quite a sizeable revenue to the college funds. How easily these things can be used by young people when the operating techniques are sufficiently user-friendly! This should beseen as a couterbalance to the opinion that it is going to be very difficult to teach young people microcomputing.

178. At one college, money had been obtained from DES to carry out training courses at the college for local school teachers. This link between secondary and further education is a valuable one and colleges should not neglect to use what is sometimes their better equipment or knowledge or expertise to form goodwill groups with the schools in their catchment area.

In another college I was told that much of the curriculum was derived from job and task analysis carried out in the 1960s. They implied that the inertia this represented came not so much from industry as from the college staff who, having got used to one system of teaching were loath to change, even though the traditional occupational structures and craft boundaries are no longer valid. (Had they forgotton TEC and BEC?)

179. FURTHER EDUCATION IN THE USA

The community colleges in the USA are those most nearly like our colleges of further education. They have many of our problems too, including a falling birth rate and difficulties in declining city areas. These colleges often have students somewhat older than ours. They include some who were being retrained in new skills and they have a stabilising influence on the college ethos. It is college opinion that those who go to them (perhaps as high as 80%) although they have a varied high school certification, are deficient in certain skills, reading, writing and general communications were specifically mentioned. They have to take at least one semester (slightly more than one term) in remedial studies. One college in New York was particularly interesting in that they have some 9000 students, 70% of whom are female and 56% are from low income families. 50% of the students are aged between 23 and 39 years. They specialise in two-year full-time courses. The peak times for attendance are from 8am and 1pm and from 5pm to 8pm. Schools and colleges in New York were beginning to acquire microprocessors but very few are for student use, but mostly for college administration. I noticed that free-standing word-processors are in use for administration. I was told the college has five of them in all.

180. There is a relatively new college in Santa Clara (in 'silicon valley') which consists of four institutes or departments, each composed of disciplines where there is a common theme. The physical science institute is responsible

for a wide spectrum of subjects from fire science technology to electronics and physics. They use video tape presentations and TV monitors to replace straight lecture material as part of some of their main courses. The electronics technician course is almost entirely available in this form. Three of the main subjects on this course are taped on over 100 video tapes which students can borrow at any time from a 'resource island'. These islands are strategically placed at convenient points close to the college institutes they served. Students taking this course to upgrade their skills have to obtain units of work experience. They have no difficulty in gaining them in industry. Santa Clara has probably the lowest unemployment in the USA, so most students gain work experience where they are employed. Material for all courses includes an appropriate handbook which the student has to buy and each section of the book states the learning objectives involved. Many of the examinations are of the multi-choice type and are automatically marked by a SCANTRON machine. There are major tests at mid-term and at the end of each semester.

Some of their students are married and the family car is used to get to work. In this context underprivileged people means one-car families! In such cases the college sends the tapes to the company where they work so that the student can go to the company's education room (most companies had them) and view the tapes in their lunch break or after work. It was explained that the college is trying to service non-traditional students whose average age is quite high - typically 30 years. Other underprivileged people work unsocial hours, such as the 'graveyard shift' (midnight to 8am). They also need course material to study at work or at home. The college is also equipped for viewing and one room I saw has about 15 viewing booths of which five were then in use.

181. Some colleges, but not this one, put their video tapes out over TV transmitters to the neighbourhood around. The college President (she is not an engineer) does not believe that the college can keep up with the state of the art in microelectronics. At some stage the President believed she would have to make a deal with local companies in exchange for teaching. "We retrain, they give us the equipment." (This seems to me to be a non-sequitor: a lack of knowledge is not necessarily offset by new equipment.)

The college library has a computer system with 20 terminals scattered about the

building. Anyone, staff or student, is permitted to operate these (it uses a menu programme) to access titles in stock by author, subject or book title.

All enrolment records are computerised and it is possible when required to call up class lists, attendance records and other data.

182. The City College in San Francisco is a large community college (California alone has 107, 2-year community colleges). It was explained that whilst the funding for a new college such as the one at Santa Clara is relatively good, funding for microelectronics in a 40-year old college like City College is far less easy; they had not been able to establish themselves in word processing. Education there is free to residents in the state of California. Although only about 40 miles from Santa Clara I was told there is a diminution of jobs due to changing technology in the San Francisco area. One saw a number of people who appeared to be unemployed, young people who 'did their own thing' to amuse people and make a few dollars.

Computing is regarded as a growth area of high prestige and training for this is on the increase. I was told, "It has not been our history to predict problems and address them before they slap us in the face. We can only deal with crises as they occur." The president of this college said that he thought that for the rest of his lifetime, job opportunities will be declining.

183. The engineering faculty of the college offers courses in electronics, including digital techniques, microprocessor hardware and software, and micro control systems for mechanical engineers. However, the laboratories did not seem particularly well equipped and looked very like an electronics laboratory in the UK in the early 1970s. The Head of the Engineering Faculty said that he has difficulty in staffing these courses. "It is very difficult to remove a member of the teaching staff even if his knowledge is completely out of date." He offered the opinion that there is some prejudice against two-year colleges in the distribution of funds, and also that the 'clause 13 dispute' has meant that they are no longer funded by the city but by California State who scrutinise spending closely.

The reaction of the Faculty Head to ethnic minorities was of some interest. For example he said that there is a substantial percentage of students for whom

English is not their mother tongue. Those of Chinese origin who are still linked with their racial group (there is a large Chinatown district in San Francisco) are industrious, but those who were no longer so involved, were far less so.

184. THE COUNCIL FOR EDUCATIONAL TECHNOLOGY (CET)

Whilst it is not the purpose of this report to detail the relevant work of the CET, it should be mentioned that they have produced articles, publicity material and information on microelectronics in education. It is pertinent to state the views expressed by CET staff regarding the subject of this project. The need for technicians, they thought, although there are no statistics to support them, will over all, remain fairly constant. A fair number of middle grade technicians will be needed to maintain production lines, although we might need less than at present of many grades except those at the top. New technology tends to be extremely reliable. The parts of a system which go wrong are the mechanical ones. One can make a distinction between items like calculators and digital watches, where there is very little maintenance needed, and domestic items such as washing machines, dish washers, cars, etc, all now using micro-processors but requiring regular maintenance.

The case has been argued in the press that microelectronics will lead to a loss of employment. Whilst some old technologies are being wiped out, the new technology is not going to replace all the jobs. It is no longer on to regard further education as providing the same specialist skills as before with few people needing them. Transferable skills are needed, rather than ones limited to any point in the development of technology. (I believe we need to teach the new skills too.)

Almost alone of the people I spoke to, CET were of the opinion that Qwerty keyboards might well be less used in future. 'Generalised keyboard skills' need to be taught so that skills with alternative keyboards can be learnt when needed. They thought that a broad information search skill is also required. The information structures we meet are not all the same these days. A variety of ways of getting information is needed and this requires teaching in colleges of further education.

185 THE TECHNICIAN EDUCATION COUNCIL (TEC)

TEC had obtained a grant from DoI to encourage the spread of microelectronics throughout British industry. The grant had been used by TEC to carry out an extensive development programme to produce learning units and associated learning packages which could be included in TEC programmes. They had designed objectives for a number of microelectronics systems at all of the the various levels of TEC programmes. There were basically two types of programme. There were those which had been introduced for technicians concerned with the design, manufacture and servicing aspects of systems incorporating microelectronic devices and those units which had been produced for technicians who required only a general understanding of the range of applications of microelectronics and their potential. The objectives for these units should consulted for their curruculum content. They had also used their information bulletin 'Tecnews' which circulates in industry and the colleges, to publish items of interest and articles on the applications of microcomputing.

186. THE BUSINESS EDUCATION COUNCIL (BEC)

BEC has taken a realistic approach to training for the business world. In the context of this report BEC has had an important impact on the training of systems analysts, programmers, computer operators, data control clerks, etc. They have issued notes for guidance for college staff to help them plan their teaching programme so as to take account of changes resulting from developments in microelectronics. These notes represent the conclusions of a working party which was established to review existing BEC courses at all levels. They point out that there is general agreement that significant changes in office practices and procedures are taking place as a result of new technology and that the rate of change and precise impact in different areas are uneven and difficult to predict. From 1982 on, their examinations will increasingly reflect the types of relevant skill and knowledge which students should have. The recommendations include familiarity with the role of advanced telecommunications and with modern electronic processing equipment; the use of microprocessors in performing realistic business tasks; and some knowledge of modern word processing facilities. BEC has drawn attention to the implications for future approval of courses and their validation. There are also resource implications for the colleges.

187. THE ROYAL SOCIETY OF ARTS (RSA)

The Royal Society of Arts produced in May 1980 a consultative document on 'The educational and training implications of modern technological developments as they affect offices and administration'. In this they drew attention to the changing role of business education in the further education sector and the impact of word processors on course provision in colleges.

An appropriate staff development programme for teachers was seen also to be needed.

The responses from industry and the colleges were substantial so that in the final report 'Office Technology - The implications for education and training in the 1980s' there was one section (Chapter 3 - the largest) on the curricular implications. It is interesting to note that the May 1980 document spoke of developments in the late 1980s, but this report is couched in more immediate terms. It is acknowledged that the developments will not be uniform in pace (see paragraph 186). It is important that young people be prepared for a rapidly changing society in which they will be totally at home with computers. They must be prepared for jobs and tasks that will use advanced technology and are likely to change rapidly. Thus they will be enabled to obtain learning skills so that they may benefit from further education and training. Curricula will need to be restructured so as to give considerably more emphasis to skill in communication. It will be necessary for students to acquire a facility to develop their thoughts and ideas, to convey and receive information orally, in writing and as appropriate in numeric, symbolic or pictorial format. The report puts special emphasis on literacy and numeracy and says that the ability to use these basic tools cannot be over emphasised. It strongly recommends that in all courses a greater importance is attached to developing each student's skill in communications. It comes down firmly in favour of the Qwerty keyboard and recommends that a basic training in keyboard skills should be made available to each student sometime during their period of secondary education. Colleges should offer training in this subject to those who for one reason or another have not been able to acquire the skill whilst at school. With reference to micro-computing, they also drew attention to the tendency to underestimate the time required for a student to gain 'hands on' experience.

They see the traditional core being replaced by one based on communication skills in business, background to business, office practices and keyboarding, to which other specialist options can be added as required. Pressure on the timetable will undoubtedly increase and as more time is devoted to the teaching of core subjects it may well be that in order to relieve this pressure, people will increasingly opt for shorthand systems which lighten the learning load.

PART NINE - CONCLUSIONS

188. The following conclusions were reached from discussions with the sample of organisations listed at the end of this report.

189. SOME GENERAL CONCLUSIONS

i. Engineering graduates and technicians will need to be better motivated and more skilled. In particular they will need to be as proficient in the development and use of software, as in the corresponding development and use of hardware. In this way they will be able to exploit alternative solutions to design problems in the applications of microprocessors.

ii. Students in a wide range of study areas will require keyboard skills. Such keyboards will in the medium term be of the Qwerty type. Professional typing speeds are not required, but ability to touch type will be advantageous.

iii. Students involved with microelectronic equipment will not be absolved from the need to have adequate literacy and numeracy. In particular, it will still be highly desirable that those entering the world of work should be able to express themselves clearly in good English.

iv. For those who use microelectronic equipment in their work, it will often be the case that the technical part of their job will be done more quickly. Where these workers will need to deal with members of the public in the course of their work, the quality of their inter-personal skills will be of greater importance than in the past.

190. AREAS OF INTEREST

In paragraph 33 it was explained that there are three areas of impact of micro-electronics on society, namely those of specialists (such as electronics engineers); users of microelectronic technology in their work; and the public who meet it in the context of life and living. It can now be seen that the group of users represents in reality a spectrum of use, thought it perhaps may

be best considered in two parts; firstly use in sectors of industry or commerce where microelectronic systems are common and often important, and secondly use in sectors of employment where the emphasis on high technology is somewhat later at the present time. A summary of perceived needs in these areas follows, with relevant paragraphs of the report quoted in parenthesis.

It has been suggested in paragraph 156 that three kinds of skill are needed; life skills, work skills and learning skills. Whilst the emphasis on these varies from one group to another, it should be noted that one of the effects of microelectronics has been to reduce work skills, though there are some important exceptions. This in turn has increased the expectations of employers for improved life skills.

There were some items raised by industrialists to which it was not easy for the author to give direct support. One of these was the need for employees to be mobile. This is a topic which could be best handled in an open discussion (paragraphs 66, 71, 129, 132).

191. THE SPECIALISTS

i. Much of the work of colleges of further education consists of the training of technicians or craftsmen. There are a number of areas of employment where it is thought that fewer technicians and craftsmen will be needed. These include manufacturing, aerospace, British Rail and British Telecom. (paragraphs 54, 115, 139, 152, 154).

ii. Whether or not one accepts the description of technician skills such as described in paragraph 52 there is some measure of agreement that greater skills will be needed in future from technicians. (paragraphs 52, 151, 185)

iii. Further education has accepted that over the last few years, remedial work has had to be done for some school leavers and especially for low achievers, before they can be employed in a worthwhile job in industry. Here too a measure of enhancement of life skills has been particularly to the fore in the comments of industrialists in the

training of technicians. Young people need to show attention to detail, greater inquisitiveness and greater ability with personal relationships and communications. (paragraphs 65, 119, 132, 156, 158)

iv. Many would wish to see improved work skills in technicians in future. (paragraphs 54, 151, 184)

v. An improvement is needed in the ability to write reports. (paragraph 118)

vi. It is important that curricular changes do not divert attention from basic topics relevant to the science of engineering, whilst attempting to introduce new skills. (paragraphs 55, 64, 68, 73)

vii. Engineers need to be equipped with skills in both hardware and software systems and to be able to employ either or both of them as components of engineering design and usage. (paragraphs 62, 68, 157)

viii. Keyboard skills are a general requirement for very many job functions, throughout the spectrum of use and technology. High speed typing skills are not necessarily needed, but familiarity with the Qwerty keyboard, perhaps through essay assignments, should be the normal approach for training in engineering. (paragraph 51)

ix. Learning skills are more easily acquired by the engineer who is well motivated. Hence opportunities should be found to increase motivation. (paragraphs 70, 138)

x. Some knowledge of business and the structure of industry is needed by those whose working life is to be spent there. (paragraphs 72, 136)

xi. The realistic assessment of career prospects and good careers advice are needed if a technician's experience of employment is to be successful. (paragraph 57)

xii. Technicians need to be taught how to handle technological change. (paragraphs 66, 151)

xiii. General curricular items which might need attention include the need to appreciate orders of magnitude (paragraph 63) and an understanding of the EEC regulations as they apply to the technicians' workplace, and awareness of the work the employer is doing for a customer. (paragraph 72)

192. USERS OF MICROELECTRONICS AT WORK

In this area we are considering people who are entering or have entered employment which involves using microelectronic equipment but who do not need to know anything about the circuitry of the equipment.

i. 'Life skills' should include the efficient use of English, in reading spelling and communication; together with improved basic mathematical ability. (paragraphs 93, 127, 129, 187)

ii. Whilst it is desirable that school leavers should have some computing skills, it may fall to FE to see that they have a sound basic knowledge of computing. (paragraph 86)

iii. The implications of the transfer from school/college to work call for changed attitudes and should be better understood. (paragraphs 159, 166)

iv. Students on TEC and BEC course will require a greater appreciation of computing and its relevance to business as the course proceeds. (paragraphs 113, 133, 163, 166, 185, 186)

v. Students must be aware of commercial constraints on the way a business operates. (paragraph 93)

vi. Lower skills in shorthand may suffice in future. (paragraphs 99, 126)

vii. Keyboard and word-processing skills are seen to be important for most people. (paragraphs 111, 126, 151, 184, 187)

viii. The role of computing as a management tool needs to be better appreciated. (paragraph 126)

ix. Search skills should be developed. (paragraph 184)

x. The young employee must be able to accept job and task changes even in his first few years in business. (paragraphs 149, 173, 184, 186)

193. MEDIUM TECHNOLOGY

This section deals with situations where the impact of high technology is still important but less critical. Typical examples are departmental stores and hotels. This is an area where technological change has thrown life-skills into sharper relief.

i. The personal skills of the store check-out operator and shop assistants will need to be of higher standard than previously (paragraphs 99, 151)

ii. Numeracy is of prime importance in these sectors of commerce. (paragraph 101)

iii. A number of employers are particularly seeking employees who have high moral standards and discipline. (paragraph 101)

iv. The social skills of hotel staff, particularly receptionists are especially important. (paragraph 108)

v. Receptionists and others need keyboard skills. (paragraph 108, 113)

vi. The importance of numeracy as well as literacy is stressed by employers. (paragraph 111)

194. THE GENERAL PUBLIC

The impact of microelectronics on the general public has been a constant theme in this report. It has been shown that there is barely any aspect of life which has not been affected; travelling, working, shopping, even hobbies and television are all in a state of change. There may be changes in the use of telephones, in banking and the postal system. This is the world with which both we and our young people will have to cope. For the intelligent and perhaps for the average young person, games like 'Space Invaders' have demonstrated that there will be little problem. The most 'user-friendly' systems will survive and operating a keyboard will be considered as normal as riding a motorbike. It still leaves, however, those who are of lower ability or who lack self-confidence, who feel insecure to travel far from home, or who are disadvantaged for one reason or another. By reading this report and looking at the changes it identifies many people, especially teachers, should be able to appreciate the problems and ease the burden for those students.

195. TEACHER TRAINING

A number of the people interviewed in compiling this report saw the solutions to some of the problems at which we have been looking, not only in terms of curricular change in the colleges, but also in changes in teacher training both for schools and for colleges. These varied from staff development to the need to teach more about industry and engineering, and the need for training in new technology.

Perhaps because a teacher's demonstrations, if well practiced, help to give confidence to a class, it was suggested that PRESTEL may have a role to play as a learning aid. There was also a suggestion that the introduction of technology teachers in schools and colleges could be used for this purpose. This time of falling school rolls, when the number of teachers in colleges of education is fewer than it has been for many years, is a good opportunity to bring in some of these changes.

Acknowledgement must be made of the generous co-operation of members of the following organisations without whose help this report could not even have been attempted.

Association of Principals of Colleges
Association of Professional, Executive, Clerical and Computer Staff
Barclays Bank Ltd, Knutsford
Barclaycard, Nottingham
Bay Area Rapid Transit District, San Francisco Ca
Bradbury, Johnson and Co. Hitchin
Brighton Technical College
British Aerospace Dynamics Group, Stevenage
British Railways Board London
British Rail Engineering Ltd, Derby
British Telecom, Lond, Cambridge and Stone
Business Education Council, London
Burroughs Machines Ltd., Glenrothes
Chase Manhattan Bank N/A, New York
Citibank N/A, New York
Commercial Union Assurance Co. Ltd, London
Council for Educational Technology, London
Cranfield Institute of Technology
Department of Education and Science, London
Department of Industry, London
Electrical and Electronic Manufacturers Training and Education Board
Ferranti Computer Systems Ltd, Manchester
Ferranti Ltd (Electronic Systems), Edinburgh
Further Education Staff College, Blagdon
General Instruments Ltd, Glenrothes
Gimbels Inc, New York
Granada TV Ltd, Bedford
Greyhound Corporation, Phoenix Az
Hatfield Polytechnic
Chris Hayes Associates Ltd, London
Heriot-Watt University, Edinburgh

Hewlett Packard Ltd, South Queensferry
HM Inspectorate of Schools and Colleges
Hotel and Catering Industry Training Board, Wembley
Inner London Education Authority
Intel Corporation, Santa Clara Ca
Intel (UK) Ltd, Swindon
ITT Ltd, Harlow
International Computers Ltd, Putney and Stevenage
Macey Inc, New York
Mancroft Filling Station, Norwich
Manhattan Borough Community College, New York
Marks and Spencer Ltd, London
Mission College, Santa Clara Ca
Motorola Inc, Semiconductor Group, Phoenix Az
Muirhead Ltd, Beckenham
National Association of Teachers in Further and Higher Education
National Computing Centre, Manchester
National Westminster Bank Ltd, London
North Herts College, Hitchin
Philips Data Systems Ltd, Colchester
Plessey Semiconductors Ltd, Swindon
Portsmouth Polytechnic
Prudential Assurance Co Ltd, London
Racal Ltd, Bracknell
Racal Semiconductors Ltd, Reading
Rank Hotels Ltd, London
Redifon Ltd, Wandsworth
Royal Society of Arts, London
J Sainsbury Ltd, London
San Francisco City Community College, Ca
Society for Long Range Planning, London
South East Electricity Board, Hove
South East Gas Board, Croydon
Square D Ltd, Swindon
St Andrews University
Standard Telephones and Cables Ltd, Southgate
Stevenage College

Swindon College

Technician Education Council, London

Texas Instruments Ltd, Bedford

TMC Ltd, Malmesbury

Trades Union Council

Trusthouses Forte Ltd, London

West Valley Joint Community College District, Ca

During the course of this investigation visits were made to about 70 organisations in industry, commerce and education. During these visits it was not unusual to be given the opportunity of meeting more than one person in a formal interview situation. In a few cases up to ten people were involved in this way. In each case there were three key areas of questioning, but the exact questions were modified to suit the circumstances of the person being interviewed and the nature of his position within the organisation where he or she was employed. Some very useful interviews were also held with people who had recently been students in FHE colleges.

The key areas of questioning were:-

1. To what extent is your organisation involved in making or using microelectronic components or equipment at the present time?

2. To what extent will your organisation have modified its position regarding microelectronics in five years' time? What are the implications of this for your business role?

3. What are the implications of these changes for employment within your organisation, for training and retraining of those you employ, and for those who seek to gain employment with your organisation?

In the case of universities, polytechnics and colleges of further education, the substance of question 3 above, was replaced by an enquiry about the changes which were forseen in the education of their students, including engineers, but not exclusively so.

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Further Education Curriculum Review and Development Unit

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